Regional Airport System Planning Analysis

2011 Update

Volume 1: **Final Report**

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Prepared by the **Regional Airport Planning Committee**

Metropolitan Transportation Commission

Bay Conservation and Development Commission

Association of Bay Area Governments

And prepared by

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1 INTRODUCTION

1.1 STUDY BACKGROUND AND OBJECTIVES

This report presents the results of the Regional Airport Planning Committee's latest assessment of the capabilities of the Bay Area's airport system to serve future (2035) growth in air passengers, air cargo, and overall aircraft operations. Airport capacity issues will lead to aggravating delays, adverse environmental impacts, and harm the Bay Area's economy because of the importance of airports to business travel and tourism.

While construction of a new runway at San Francisco International Airport (SFO) or Oakland International Airport (OAK) would provide significant new capacity as noted in the 2000 Regional Airport System Planning Analysis (RASPA), these solutions are not the focus of this analysis. Due to the potentially large expense of building one or more new runway(s) and given the multitude of changes since the 2000 RASPA, the purpose of this update was instead to assess whether future aviation demand could be accommodated with other options beyond expanding runways. Thus this study provides a look at less costly alternatives to these major capital investments and a determination about how well these alternatives can serve as substitutes for additional runways. As explained below in greater detail, the main strategies that have been evaluated are as follows:

- Redistribution of air passenger demand among the three major Bay Area airports (SFO, OAK and Norman Y. Mineta San Jose International Airport (SJC))
- Airline use of alternative airports inside the Bay Area
- Expansion of airline service at airports outside the Bay Area
- High Speed Rail in the California Corridor
- Demand Management
- New Air Traffic Control (ATC) Technologies

The study recommends that the Bay Area pursue Scenario B, which assumes a major redistribution of air passenger traffic from SFO to OAK and SJC as well as embodies elements of most all of the other strategies listed above, as the best approach for satisfying the region's projected long-range aviation demand. This strategy would not require new runway development at the existing airports. However, if the major

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strategies in Scenario B do not come to fruition to the extent planned, then future updates of the RASPA will likely need to assess other approaches, possibly including new runway development.

Although the focus of the study has been on airport runway capacity, the FAA will need to further evaluate airspace capacity in light of increasing demand and the need to configure the airspace to make the best use of the next generation air traffic control and management technologies currently under development.

Lastly, a number of technical studies have been completed which are summarized in the following sections and which inform the major recommendations contained in this report (see Appendix, Exhibit 18; these individual technical studies are combined in a separate companion report to the Final Report). Based on this extensive foundation of information, this Final Report provides a series of recommendations targeted at addressing key issues. It also presents a preliminary work plan that will assist in the implementation of Scenario B as well as address questions that remain to be evaluated in greater depth.

This update of the Regional Airport System Planning Analysis (RASPA) will be included in the regional plans of the three RAPC agencies and will replace in entirety the results of the last planning analysis from 2000.

1.2 UNCERTAINTIES

As always, there are many unknowns that will affect the timing and severity of future capacity problems and that make precise answers difficult. Some of the key uncertainties that will affect future airport plans are:

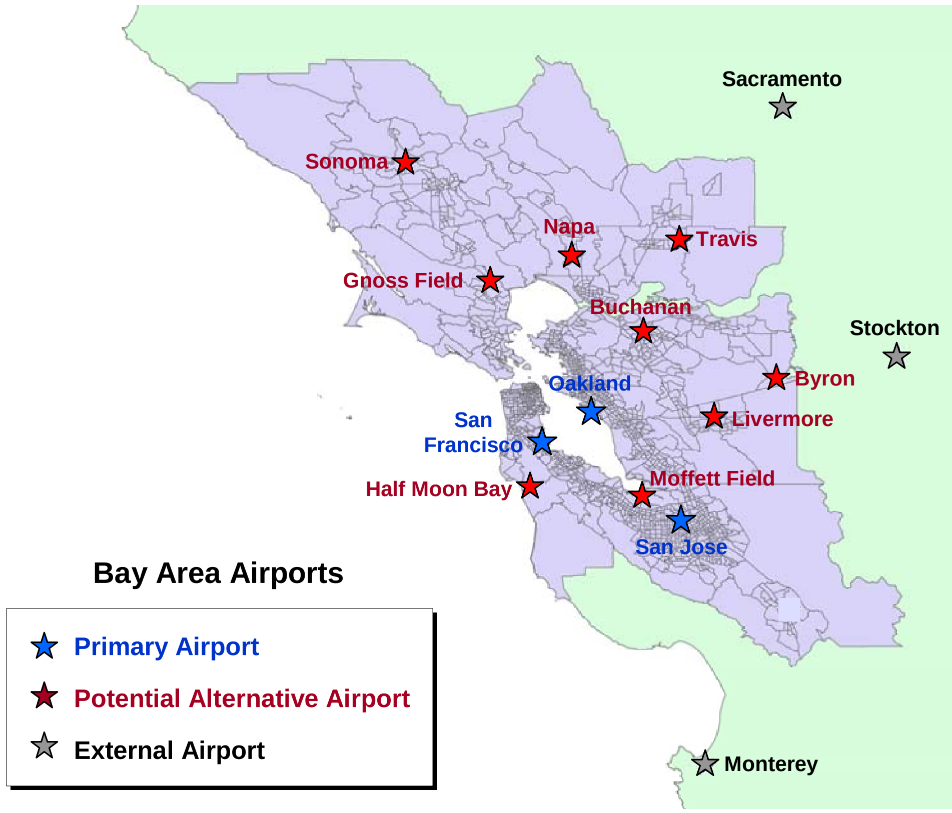
- The forecasts of aviation demand are subject to change as new events alter the economy and re-shape the business environment within which airlines operate.
- How airlines will choose to serve each Bay Area airport in the future is a major unknown, in terms of cities served, number of flights provided and fares. Thus predicting which airports will grow the most is a difficult and complex exercise.
- New Air Traffic Control technologies under development by the FAA will provide powerful tools for dealing with future airport and airspace capacity challenges, but there are many funding and stakeholder issues to resolve. The timing for the deployment of specific technologies is difficult to determine.
- A similar situation exists for High Speed Rail, which can provide an alternative way for air travelers to reach many California destinations. Planning is well underway, but the system is ambitious and many implementation steps remain, including securing all the required funding.
- Strategies airports may employ to control demand on their runways (called Demand Management) are largely untested, including new FAA policies that would allow airports to price activity by hour based on levels of congestion.

1.3 SCOPE OF THE STUDY

The approach taken by RAPC in this review is new and unique in that it recognizes the larger region served by the Bay Area airports and the contribution that airports outside the nine-county Bay Area can make to solve runway congestion problems facing the Bay Area airports. While air passengers in areas such as Sacramento, Stockton, and Monterey have access to airline service, many of the passengers originating in these areas use the Bay Area airports because of better flight availability, frequency or fares. Conversely some resident Bay Area air passengers find Sacramento more convenient to use because it is closer to their ground origin. Representatives from Sacramento, Stockton, and Monterey airports have participated in discussions with RAPC and assisted in developing the recommendations that follow.

Additionally the study has taken a closer look at a number of the region's other secondary airports, including military and federal airports, to evaluate what role these facilities might play in accommodating a portion of the projected growth in air passenger or air cargo demand. (See Figure 1-1)

Figure 1-1: Bay Area and External Airports Considered in the Study



1.3.1 Airports in the Bay Area Region

San Francisco International Airport (SFO)

SFO is the largest airport in the region, and a hub for United Airlines. It provides a wide range of domestic airline service and all of the region's long-haul international flights. Recently, due to reduced weather delays, lower airport costs and competitive factors, low cost airlines have re-established a strong presence at SFO effectively competing with low cost services that used to be concentrated at Oakland and to a lesser extent, San Jose Airports. San Francisco serves 68% of regional air passengers and 43% of regional air cargo shipments (based on 2009 operating statistics).

Metropolitan Oakland International Airport (OAK)

Oakland Airport has traditionally been the hub for low cost carriers and a major air cargo center due to operations by FedEx and UPS. Recent economic conditions and airline service decisions have caused a reduction in scheduled passenger flights at OAK, and a realignment of low cost airline service among the Bay Area's three primary airports. Oakland currently serves 17% of regional air passengers and 52% of air cargo (2009).

Norman Y. Mineta San Jose International Airport (SJC)

Traffic at San Jose Airport has also been affected by the recent realignment of airline services in the Bay Area, but to a somewhat lesser extent than Oakland Airport. The airport does not currently offer any long-haul international flights, and air cargo facilities are limited due to space constraints. San Jose currently serves 15% of the regional air passengers and 6% of air cargo (2009).

Sonoma County Airport (STS)

Because of its distance from the primary airports, Sonoma County Airport has been able to support airline service for local air passengers to destinations such as Los Angeles, Portland, Seattle, and Las Vegas. About 182,000 passengers used the airport in 2009, representing approximately 0.3 percent of Bay Area air passengers.

Other Bay Area Airports

A number of the Bay Area's other airports were evaluated to determine their potential for future air passenger service: Travis AFB, Napa County, Buchanan Field (Concord), Byron Airport, Moffett Federal Airfield, Livermore, Half Moon Bay, and Gnoss Field. Although a number of the secondary airports evaluated would not have the physical ability or air passenger demand to support airline service, the region's general aviation airports do divert small plane traffic from the primary airport runways and thus constitute an important part of the region's approach to mitigating runway congestion problems.

1.3.2 Airports in the Surrounding Region

Sacramento International Airport (SMF)

The Sacramento Airport served nearly 9 million passengers in 2009 with 147 daily departures to 33 destinations (August 2009). Southwest provides the majority of flights. Many Sacramento area air passengers use Oakland and San Francisco for their air service needs. Conversely a number of Solano and Napa County air passengers choose Sacramento Airport due to its access convenience from these areas.

Stockton Metropolitan Airport

Stockton is served by one airline, Allegiant Airlines, with five weekly departures to Las Vegas. About 55,000 air passengers used Stockton Airport in 2009.

Monterey Peninsula Airport

Monterey handles approximately 400,000 air passengers a year and was served with 17 daily departures to 6 destinations in August 2009. The airport is currently served by four airlines (United, American, US Airways, and Allegiant). Many Monterey area air passengers use SJC and SFO for their air service needs.

2

STUDY VISION AND GOALS

2.1 VISION FOR THE BAY AREA AIRPORT SYSTEM

RAPC envisions an airport system that will provide for the needs of Bay Area air passengers and air cargo users and has the following general attributes:

- Passengers will have a choice of more flights (or trains) at more airports
- There will be fewer weather-related flight delays
- Airport noise impacts on the regional population will be minimized
- Adverse air quality and climate change impacts will be minimized
- Surface travel to airports will take less time
- The airport system will support regional economic expansion

2.2 STUDY GOALS

These airport system attributes were translated into seven specific goals as described below. The goals provide a dual use, as they both express a desired outcome for the Bay Area's aviation system plans as well as provide a means to measure the performance of different long-range solutions for handling future demand. As is often the case, there will be tradeoffs between the various goals and the importance placed on these goals by different interest groups within the Bay Area community.

Reliable Runways - *Can we reduce flight delays and passenger inconvenience?*

This goal addresses the central planning questions of the study—will the airport system have adequate capacity (related to runway delays), and when will each airport reach its runway capacity limits? Two measures were used to assess scenario performance for this goal:

- Average minutes of runway delay per flight
- Average minutes of delay per flight during the three busiest hours

The second measure, the average minutes of delay per flight during the three busiest hours, was evaluated at the request of study participants to capture the impact of peak airline schedules on airport delays.

Healthy Economy - ***Can the region serve future aviation demand and support a healthy economy?***

The Bay Area airports will support growth in the regional economy if they can accommodate more traffic with fewer delays. Delayed or cancelled flights represent a cost to the economy, which is difficult to measure, but exists as a real cost. Business meetings, tourist dollars, and local tax revenues are all affected by poor airport performance. Because this goal is closely related to the Reliable Runway Goal, it is measured in the same way.

Good Passenger Service - ***Can we provide better service to the region's major air travel markets?***

This goal captures the desire for Bay Area air travelers to have frequent service to the most desired destinations. The goal also captures the impact of California's planned High Speed Rail system on passenger service by including the HSR train frequencies in the calculation of the good passenger service metric:

- The number of scheduled flight departures and trains to the top 15 Bay Area air travel markets divided by the Bay Area population (i.e., departures per capita)

Convenient Airports - ***Can we maintain or improve airport ground access times and costs?***

Bay Area air travelers would prefer to minimize ground travel time and cost in their choice and use of Bay Area airports. There are three performance measures involved in assessing airport ground access convenience:

- Average distance that Bay Area air passengers travel to an airport (in miles);
- Average time it takes to reach an airport (in minutes); and
- The transportation cost of getting to the airport (i.e., tolls, transit fares, parking, etc)

Climate Protection - ***Can we decrease Greenhouse Gas (GHG) emissions from aircraft and air passengers traveling to airports?***

Both aircraft and vehicles used by air passengers for airport access produce GHGs which contribute to global warming (primarily CO2). These emissions were estimated to determine the total increase that is likely as air traffic grows at each airport, as well as the relative contribution of aircraft and vehicles. The performance measure for this goal is expressed as:

- Daily tons of CO^2

Clean Air- ***Can we decrease air pollution from aircraft and air passengers traveling to airports?***

Aircraft and vehicles used by air passengers for airport access also produce Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NOx) emissions that contribute to Bay Area smog. Similar to GHGs, these emissions were estimated to determine the total increase in emissions as well as the relative contribution of aircraft and ground access vehicles.

- The performance measure used is combined daily tons of VOCs and NOx.

Livable Communities - ***Can we avoid increasing the regional population exposed to aircraft noise?***

Airport noise affects the quality of life for people living around airports. The Bay Area population exposed to airport noise levels above the state noise standard has generally declined around each Bay Area airport in recent years as a result of aircraft technology, lower traffic volumes, and aggressive noise mitigation strategies implemented by the commercial airports. However, this trend could reverse as air passenger and air cargo flights increase in the future, and the airports may be required to geographically expand their respective mitigation boundaries. Two performance measures were used for this goal:

- The future population within the 65 CNEL noise contour (the state standard)
- The future population within the 55 CNEL contour (an area which also generates noise complaints from residents)

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3 FORECASTS OF FUTURE DEMAND

3.1 FORECAST REGIONAL PASSENGER AND CARGO DEMAND

The forecasts provide the beginning point for the capacity analysis as they define the number of air passenger, air cargo, and general aviation flights the Bay Area airports will serve in the future. Developing new forecasts for growth in air passengers and air cargo at each Bay Area airport is not an easy exercise because of the number of variables that affect demand and the difficulty in accurately predicting how these key variables will change in the future. To bracket the likely range of demand in 2020 and 2035, the two planning horizons for this study, a High, Medium, and Low forecast was prepared. The Medium, or Base Case, forecast essentially represents the best estimate of what is likely to occur in the future based on current trends and conditions. The results of the forecast are presented in Table 3-1.

3.1.1 Growth in Air Passengers

Under the Base Case forecast, total Bay Area air passengers would grow by 67% from 60.6 million annual air passengers in 2007 to 101.3 million annual passengers in 2035. (See Figure 3-1) This overall passenger forecast represents the sum of separately developed forecasts for the domestic, international, and connecting traffic segments. Major factors considered in developing the forecast for future domestic air passengers were the projected growth in Bay Area personal income, the cost of fuel and its impact on future airline fares, and an overall adjustment in the forecast equation for structural changes in the airline industry that occurred since the Dot.com bust and 9/11. Various industry forecasts for growth in overall U.S. - international air passengers were reviewed, and a long-term consensus forecast for the U.S. market was selected for use in this study. Future Bay Area international passengers were developed based on SFO's share of the U.S.-international market by world region.

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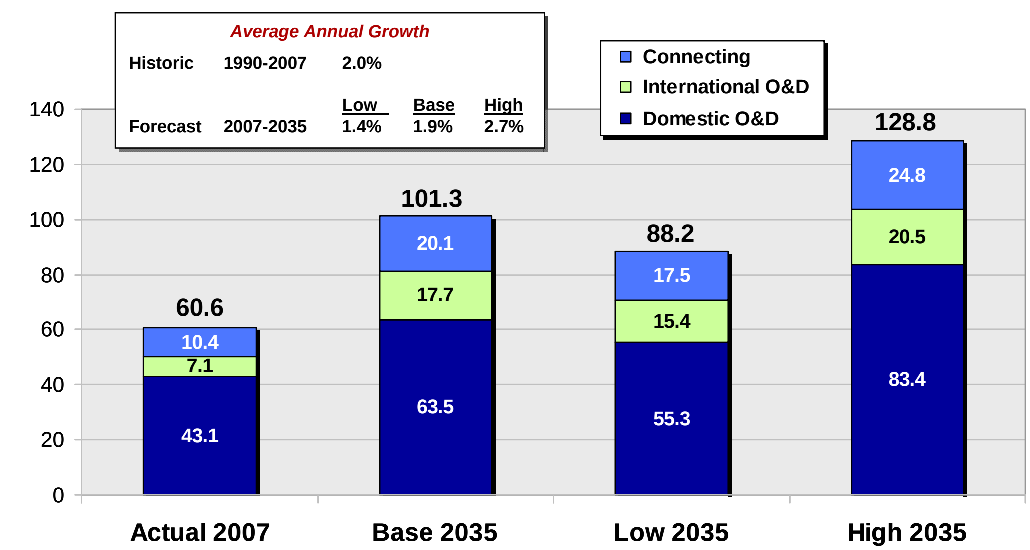
Figure 3-1: Forecast Bay Area Passenger Demand by Forecast Scenario



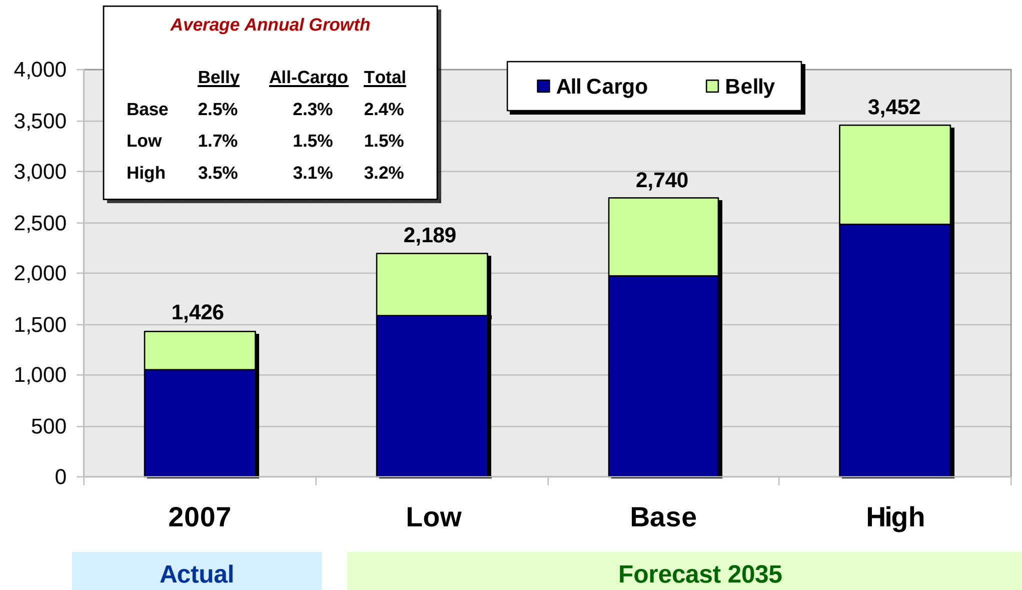
Note: Enplaned plus deplaned passengers.

The largest growth in air passengers is forecast to occur at SFO as international flights increase and low cost airlines that have recently gravitated to SFO continue to expand service. OAK and SJC shares of domestic air passenger traffic are forecast to rebound from their current depressed levels (see Exhibit 1 in the Appendix) to their average shares in 2006 and 2008. These airports are also expected to attract additional transborder services to Mexico and Canada. Sonoma County Airport is expected to receive some additional short haul flights, including some to major airline hubs, and passenger volumes are projected to grow to about 0.7 million annual passengers in 2035.

3.1.2 Growth in Air Cargo

Air cargo growth is tied to economic growth in the U.S. and abroad and is forecast to increase by 92% in terms of weight over the forecast period. Forecasts of air cargo under the Base, Low and High scenarios are shown in Figure 3-2. These forecasts were developed by consulting a range of recent long-term forecasts from various industry experts, with adjustments to reflect current economic conditions. SFO's share of Bay Area air cargo demand would grow to 51%, which is largely due to the projected increase in international air cargo, while OAK's share would drop to 43%. A portion of the region's air cargo demand would be carried in the belly compartments of passenger aircraft and the rest would be carried in dedicated "all-cargo" aircraft. All-cargo flights would increase by 94% at SFO (mostly international) and by 26% at OAK and SJC.

Figure 3-2: Forecast Bay Area Cargo Tons by Forecast Scenario



Note: Enplaned plus deplaned cargo.

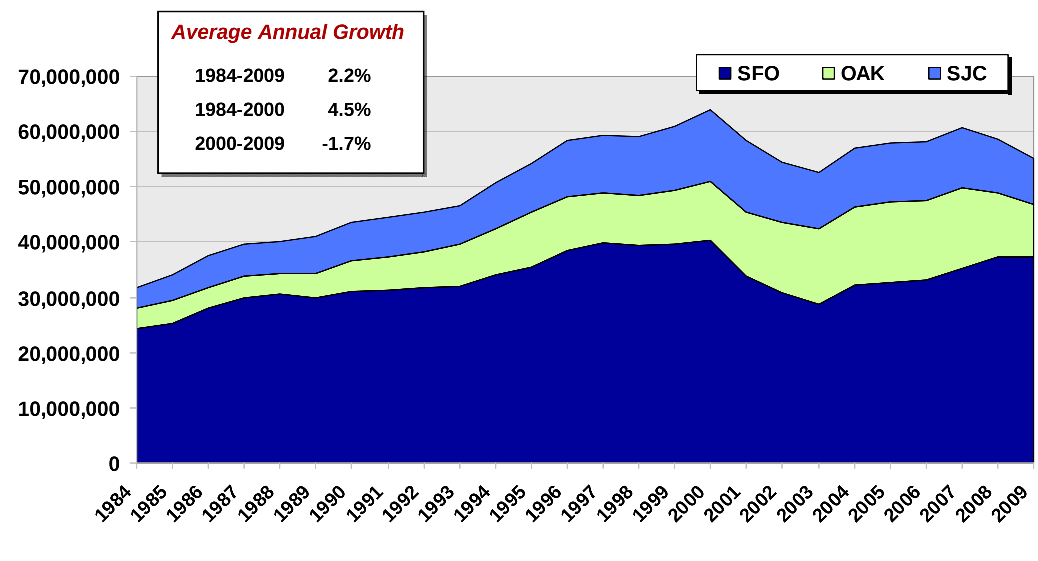
Table 3-1: Summary of Regional Passenger and Cargo demand Forecasts by Forecast Scenario

	Passengers (millions)			Cargo Tons (thousands)		
	Low	Base	High	Low	Base	High
Actual						
2007		60.6			1,426	
Forecast						
2020	68.7	75.3	86.9	1,668	1,805	1,953
2035	88.2	101.3	128.8	2,189	2,740	3,452
Percent Change						
2007-2020	13.3%	24.3%	43.3%	17.0%	26.6%	37.0%
2007-2035	45.6%	67.2%	112.5%	53.5%	92.1%	142.1%

3.1.3 Forecasts for Individual Airports

The air passenger forecasts for the individual airports are probably the most volatile forecasts because it is difficult to predict the decisions that will be made a long time in the future by domestic and foreign airlines. For example, while the study assumes that San Francisco Airport will remain the primary airport for international service, both OAK and SJC may in fact gain some international service that the study cannot foresee at the present time. The forecasts predict that SFO will also serve the largest share of air cargo demand, based on the fact that this cargo is often carried in the belly of passenger flights. (See Figure 3-4 and Figure 3-5) However, new security requirements for air cargo may change this assumption in the future due to additional screening requirements. These types of issues point to the need for regular monitoring of the forecast assumptions and their effect on the forecasts themselves.

Figure 3-3: Historic Bay Area Passengers by Airport



Source: ACI, and individual airport statistics.

Figure 3-4: Forecast Base Case Air Passengers by Airport, *(millions)*

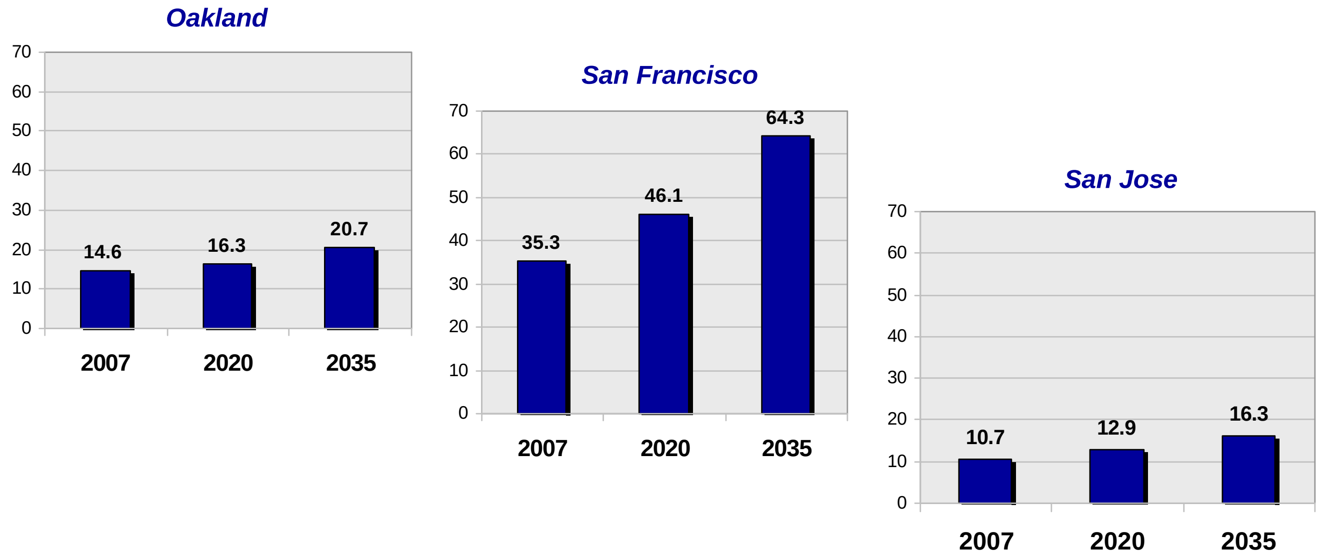
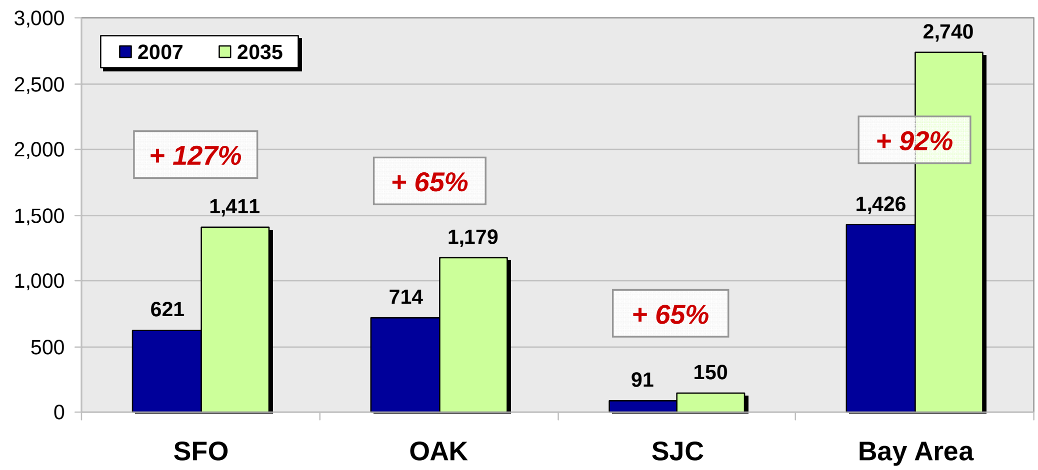


Figure 3-5: Base Case Air Cargo Forecast by Airport, *(thousands of tons)*



3.2 Forecast Commercial and General Aviation Aircraft Operations

Airline passenger flights at the primary airports are forecast to grow more slowly than air passengers, as aircraft size and load factors increase over time, resulting in a 32% overall increase in flights. Forecast aircraft operations at OAK, SFO and SJC are presented in Table 3-2. Commercial air passenger flights were estimated based on the types of aircraft airlines were projected to use in 2020 and 2035 and the expected load factors. The number of all cargo flights at each airport was estimated by determining how much cargo would fly in the belly of air passenger aircraft and how much would be carried in dedicated all cargo aircraft, factoring in potential increases in the size of all cargo aircraft. General aviation aircraft also use the air carrier runways at each airport and must be included in the overall activity forecasts. At SFO and SJC, business jet aircraft use the same runways as the airlines, but at OAK the North Field handles most of the general aviation activity though some business jets use the main runway for noise abatement reasons. Overall business jet activity at the three Bay Area airports is forecast to increase 56% above today's levels.

Table 3-2: Base Case Aircraft Operations Forecast by Airport

	Oakland			San Francisco			San Jose		
	2007	2020	2035	2007	2020	2035	2007	2020	2035
Passenger Airlines	156,000	161,000	193,000	326,000	385,000	461,000	128,000	130,000	153,000
All-cargo Airlines	32,000	34,000	40,000	10,000	12,000	19,000	3,000	3,000	4,000
GA - Jets	19,000	23,000	33,000	28,000	27,000	39,000	29,000	31,000	44,000
All Other	-	-	-	9,000	7,000	7,000	-	-	-
Total Air Carrier Runways	**207,000**	**218,000**	**267,000**	**373,000**	**431,000**	**526,000**	**160,000**	**164,000**	**201,000**
GA Runways	130,000	82,000	88,000	-	-	-	40,000	39,000	42,000
Total Airport	**337,000**	**301,000**	**355,000**	**373,000**	**431,000**	**526,000**	**200,000**	**203,000**	**243,000**

4 RUNWAY CAPACITY AND DELAYS

4.1 INTRODUCTION

Central to the main purpose of this study are two key questions:

- What are the capacity limits of the Bay Area airports? and
- When will they be reached?

Runway capacity problems are manifested in delayed and cancelled flights, which inconvenience air passengers and increase operating costs for the airlines and can also lead to higher fares. The most delay-prone airport in the Bay Area has historically been SFO, which has also ranked as one of the most delay-prone airports in the country. For this reason SFO's capacity problems are not only a local problem and inconvenience, but SFO's delays also affect operations throughout the national air transportation system. SFO will remain the Bay Area airport with the most significant runway capacity problems and therefore is the focus of a number of the strategies that have been evaluated in this study. One reason for this assessment is that, unlike previous regional airport forecasts, it is now believed that SFO will remain dominant in not only the international market but also in the domestic market for air service due to recent events and airline decisions. Thus, projected increases in airline flights will tax SFO's runway capacity and produce high delays, while leaving significant runway capacity available at OAK and SJC. The chief cause of these delays is bad weather when foggy mornings and seasonal storms limit SFO to one runway for arriving aircraft versus the normal two runways that can be used in good weather.

The capacity analysis for the study is based on a computer model that calculates runway capacity for different runway use configurations and then feeds this information into another model along with the forecasted number of flights to estimate average aircraft delays. In simple terms, runway capacity is the number of aircraft operations that can be handled by an airport's runways without producing unacceptable levels of delay. Key determinants in this calculation are the runway layout (see Exhibits 15-17 in the Appendix), weather conditions, operational procedures used by the FAA, and types of aircraft forecasted to use the airports and their weight classes (which determine the amount of separation distance required between aircraft to avoid wake turbulence problems and maintain safe operations).

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4.2 ESTIMATED AIRFIELD CAPACITIES FOR THE BAY AREA AIRPORTS

4.2.1 San Francisco International Airport

The major airfield capacity issues at SFO are the variability of weather conditions, the forecast growth of traffic through 2035, and the physical layout of the runways with its two sets of intersecting and closely spaced parallel runways. The airport can handle 61-100 aircraft landings and takeoffs an hour, depending on weather conditions. (See Table 4-1) Runway capacity problems occur when stratus clouds over the Bay or unfavorable winds preclude use of paired aircraft approaches to runways 28L and 28R (due to the close, only 750 ft, separation of these parallel runways).

Even with the use of paired aircraft arrivals under Simultaneous Offset Instrument Approaches (SOIA), a procedure that can be used in some reduced visibility conditions, runway capacity is reduced by about 20% and average delays can approach unacceptable levels at today's traffic volumes. Accounting for the different weather conditions and runway use configurations, it is estimated that SFO's runways can handle between 460,000 and 485,000 annual aircraft takeoffs and landings.

4.2.2 Oakland International Airport

OAK's main runway is used for nearly all commercial passenger and air cargo flights, as well as some business general aviation aircraft for noise abatement. The three runways on the North Field have restrictions on turbojet operations and are used almost exclusively by general aviation, including training fights, as well as some charter and cargo flights. For the most prevalent weather conditions, the airport's hourly capacity is between 54 and 85 takeoffs and landings an hour. A significant capacity issue occurs when there are winds from the East and during instrument weather conditions. With winds from the East, the current location of the glide slope antenna is such that aircraft must wait further back from the runway to avoid signal interference, creating extra delays for aircraft to get into departure position on the runway. . The estimated runway capacity at OAK, including both the North and South runway complexes, is 420,000 to 450,000 annual takeoffs and landings. The analysis assumes that various runway/taxiway improvements contemplated in the airport's adopted master plan will be completed and that airspace conflicts affecting morning departures from OAK and SFO will be reduced in the future.

4.2.3 San Jose International Airport

SJC has two main runways which are used by commercial airlines as well as business jets. The hourly capacity varies between 64 to 103 landings and takeoffs an hour for the most prevalent weather conditions. (See Table 4-1) The ultimate airfield capacity for SJC is projected to be between 520,000 and 550,000 annual operations based on the forecast fleet mix, although terminal gate capacity may limit activity to lower levels. Given the current forecasts, SJC is not expected to experience runway capacity problems until well after 2035. In 2035, the average delay under all weather conditions is expected to be only about 1 minute per flight. Even during bad weather when aircraft are operating under instrument conditions (less than 3% of the time), the average delay for SJC is projected to be less than 7 minutes in 2035.

Table 4-1: Hourly Airport Capacities by Weather Condition

Airport	Configuration	Percent of Time Used	Operations per Hour
SFO	West VFR	58%	100
	West MVFR*	21%	81
	West IFR	10%	61
	SOIA	2%	81
OAK	West VFR	77%	85
	West IFR	16%	54
SJC	West VFR	81%	103
	West MVFR*	12%	65
	East VFR	3%	98

Table 4-2 below shows each airport's capacity in relation to forecasted levels of annual aircraft operations, which include all passenger, cargo, and general aviation flights (in the case of OAK, capacity is total airport capacity including operations on the separate North Field runways used predominantly by general aviation aircraft).

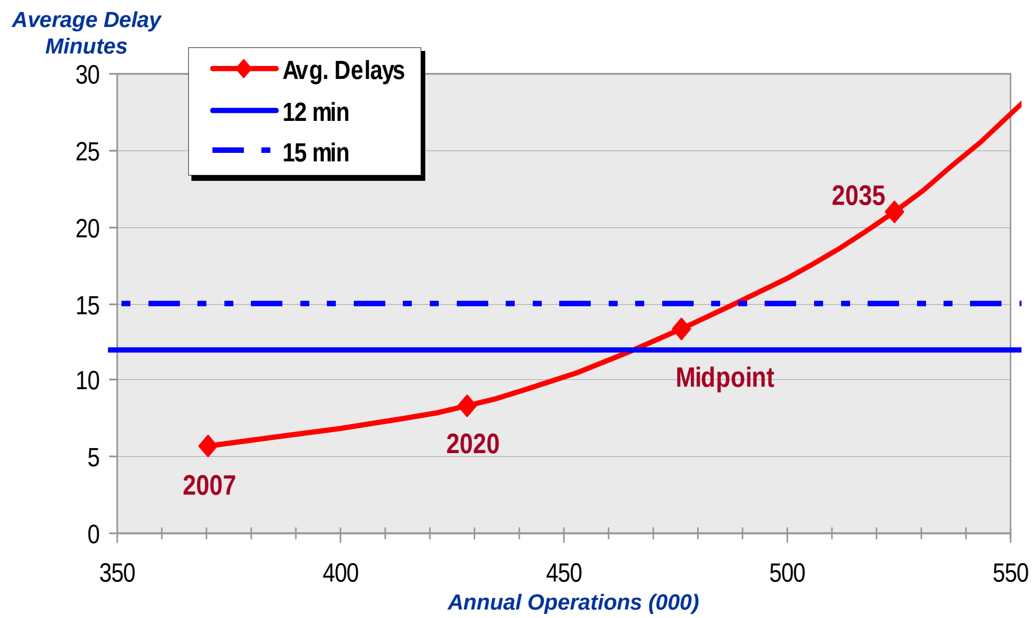
Table 4-2: Comparison of Forecast Aircraft Operations and Annual Airport Capacities

	Aircraft Operations		
	OAK	SFO	SJC
Estimated Annual Capacity	420,000-450,000	460,000-485,000	520,000-550,000
Actual 2007	337,000	373,000	200,000
Forecast 2020	301,000	431,000	203,000
Forecast 2035	355,000	527,000	243,000

Note: Includes passenger, all-cargo and general aviation operations.

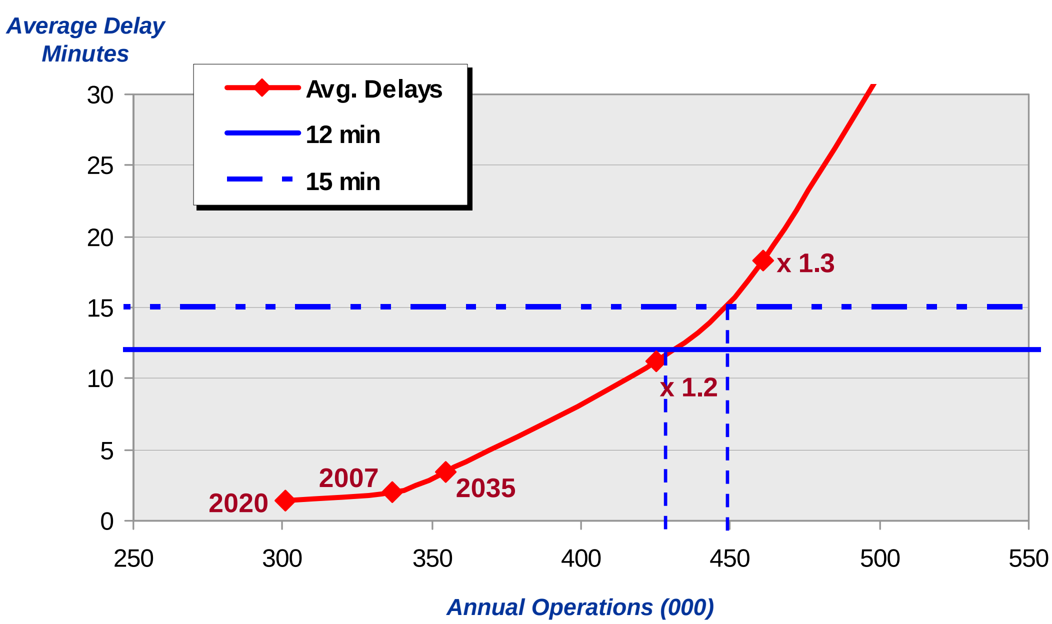
The capacity and delay information can be expressed as delay curves for each airport as shown in Figures 4-1 to 4-3. The level of acceptable delay adopted for this study was 12-15 minutes per flight (using lower levels of acceptable delay, as advocated by some study participants, would reduce the capacity values as shown in the charts). When the estimated number of annual aircraft operations results in average delays above these defined acceptable levels, the airport would essentially be operating "over capacity". In 2035, SFO's average delays are estimated at 21 minutes, well above the acceptable threshold, but OAK and SJC delays are estimated to remain well below the thresholds. Under the Baseline forecast, SFO could experience the onset of significant recurring delays sometime after 2020. See Exhibits 5-7 in the Appendix for a comparison of 2007 and forecast 2020 and 2035 hourly demand to airport capacities.

Figure 4-1: SFO Delay Curve



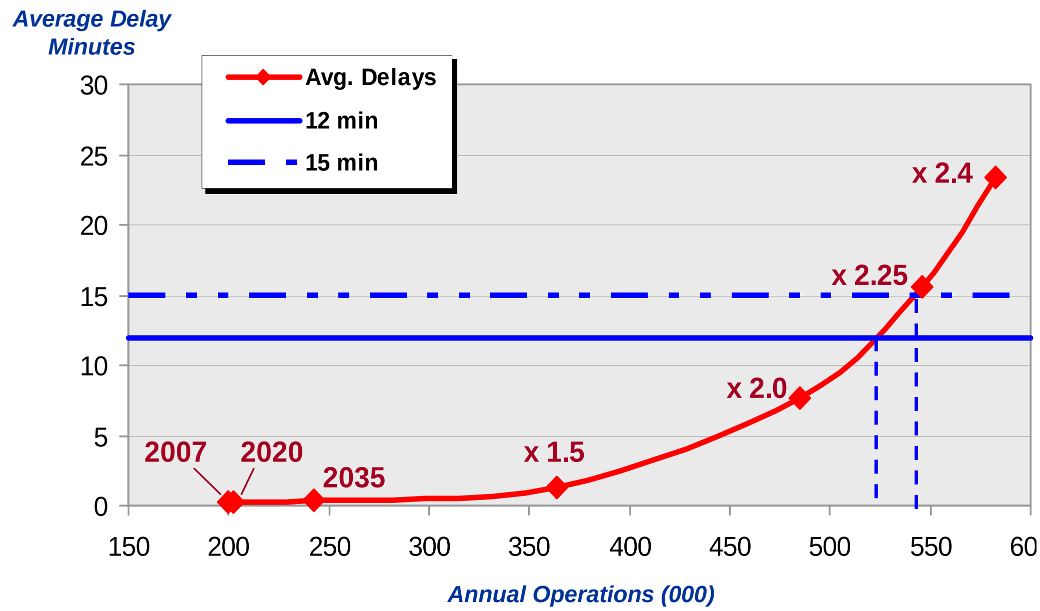
Note: "Midpoint" = the average of 2020 and 2035 operations

Figure 4-2: OAK Delay Curve



Notes: Capacities are for North and South Fields combined.
"x1.2" = 1.2 times 2035 operations; "x1.3" = 1.3 times 2035 operations

Figure 4-3: SJC Delay Curve



5 AIRPORT SYSTEM SCENARIOS EVALUATED TO SERVE FUTURE DEMAND

5.1 POTENTIAL STRATEGIES FOR SERVING FUTURE DEMAND

Having prepared the activity forecasts for 2035 and assessed the runway capacity situation at each airport, the study turned to evaluating potential strategies (called “Scenarios”) that could serve the projected number of air passenger, air cargo, and general aviation flights. The capacity analysis clearly indicates that the main capacity problems are those at SFO. Thus the Scenarios that were defined attempt to address SFO’s projected capacity problems in one or more of the following ways:

- Reduce the total number of flights into and out of SFO by shifting some flights to other airports, principally OAK and SJC;
- Shift Bay Area air travelers to other modes, such as High Speed Rail;
- Reduce aircraft activity at SFO during the most delay-prone hours of the day by managing demand; and
- Increase poor weather capacity at SFO (and other Bay Area airports) by implementing new air traffic control and management technologies.

5.1.1 Base Case Scenario

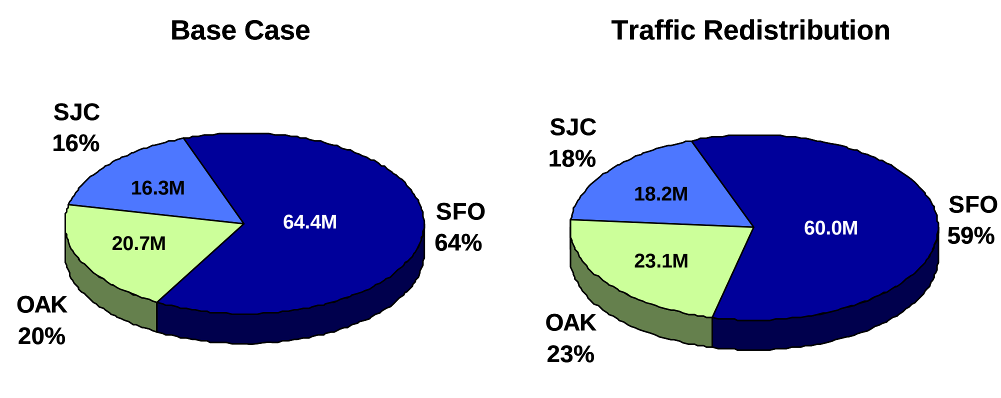
The Base Case Scenario reflects the air passenger and air cargo demand expected at each airport, irrespective of available runway capacity. It also serves as the reference Scenario for the Goals analysis which follows. While aircraft runway volumes forecasted for SFO exceed its runway capacity, SFO could theoretically accommodate this level of activity through a combination of new Air Traffic Control technologies and demand management approaches as explained below.

5.1.2 Traffic Redistribution Scenario

This scenario assumes that the build-up of delays at SFO will degrade airline schedule reliability and increase costs, thereby creating a situation in which the airlines will shift some domestic flights over to OAK and SJC which have excess runway capacity. Under airline deregulation, there is no role for government agencies in specifying which airports an airline must use, as these decisions are exclusively made by the airlines based on their potential for profit and other competitive factors.[1] OAK and SJC will certainly encourage additional services through their marketing efforts and by keeping airport costs as low as possible. This Scenario envisions a modest redistribution of domestic flights and some new transborder services, driven by delays at SFO, and the assumption that there will be airlines interested in opportunities to expand services at competitive fares at OAK and SJC. The market shares for OAK and SJC are closer to their historic shares before the new low cost airlines began their buildup of service at SFO. (See Figure 5-1) The results of these assumptions are:

- Four million passengers are estimated to shift from SFO to OAK and SJC in 2035.
- SFO passenger shares decline from 64% to 59%, OAK shares increase from 20% to 23% and SJC shares increase from 16% to 18%
- Total flights at SFO decline by 7.1%.

Figure 5-1: Comparison of Forecast Passengers by Airport - *Base Case vs. Traffic Redistribution, 2035*



[1] However, changes to the U.S. DOT Airport Rates and Charges policy allow the operator of a congested airport to include the airfield costs of a secondary airport under its ownership in the peak period charges at the congested airport, to encourage airlines to shift services to the uncongested secondary airport.

5.1.3 Alternate Internal Airports Scenario

This Scenario assumes that some air passenger demand can be served at smaller, secondary airports in the 9-county Bay Area region. All the secondary airports in the region including federal facilities such as Moffett Federal Airfield (operated by NASA) and Travis Air Force Base were assessed for their potential to support commercial air passenger services based on the passenger volumes they could capture as well as other evaluation factors. As shown in Figure 5-2, potential secondary airports selected for inclusion in this Scenario were Charles M. Schulz-Sonoma County Airport (assumes new services to additional cities), Travis AFB (through a potential joint use arrangement with the military--this airport had feeder flights to SFO in the early 70's), and Buchanan Field in Concord (this airport received limited airline service to some California airports in the past). This does not mean that other airports could not be considered; rather, these three airports scored the best in the initial evaluation and were therefore selected for that reason.

Based on estimated local air passenger demand in 2035, these secondary airports could support airline services to five high density short haul markets (Los Angeles, San Diego, Las Vegas, Portland, and Seattle) and 2 major airline connecting hubs (e.g., Denver, Phoenix, Salt Lake City). Forecast passengers by airport in the Internal Alternate Airport Scenario are presented in Figure 5-3.

The success of this scenario is dependent upon the airlines' willingness to introduce competitive services at the secondary airports. An airline's decision to enter a secondary airport market will be based on several considerations including: the inability to grow or serve its passenger base from the primary airports because of capacity constraints; potential passenger demand at the secondary airports, specifically the ability to expand its Bay Area market share through incremental passenger growth rather than simply diverting passengers from one airport to another; the market's strategic fit with the airline's business strategy; the availability of aircraft properly sized for the market; and the costs of opening and staffing a new station. Regional efforts to increase the utilization of secondary airports proved useful in the Boston metropolitan area, when Southwest Airlines entered the T.F. Green Airport in Providence and the Manchester Airport in New Hampshire in the late 1990s. Services introduced at secondary airports will need to operate profitably for the airline to continue those services. Because airlines can enter and exit air travel markets at their own discretion, there is some financial risk assumed by the secondary airport operator when building new facilities to serve a potential new airline customer base.

- Together the three alternate airports evaluated could shift up to 2.6 million passengers from the primary airports (1.2 million diverted from SFO and 1.4 million from OAK).
- Airline passenger flights at the primary airports would be reduced by 2.7% (approximately 24,000 annual flights) or, 2.1% of total airport flights, and 2.0% of SFO flights.
- The total number of airline passenger flights at all the Bay Area airports would actually increase by a small amount, as smaller aircraft are used at the secondary airports, replacing larger capacity passenger jets at the primary airports (alternate airports would be served by 70-seat regional jets or turboprop aircraft).

Figure 5-2: Secondary Airports Included in the Alternate Internal Airports Scenario

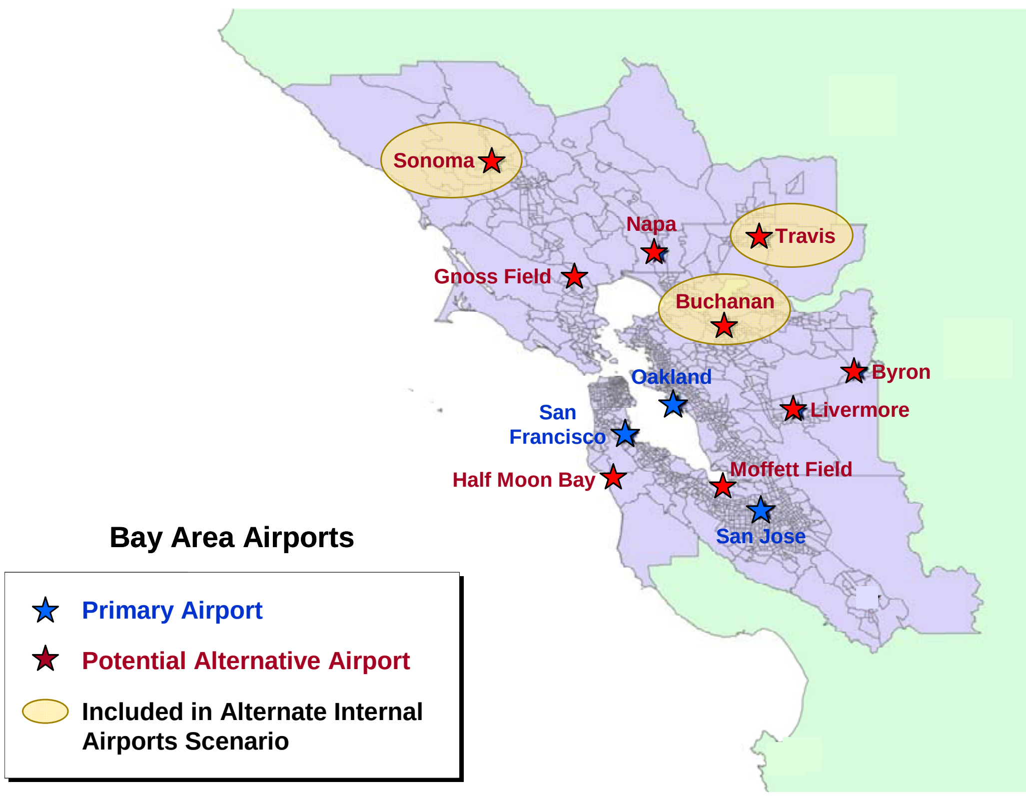
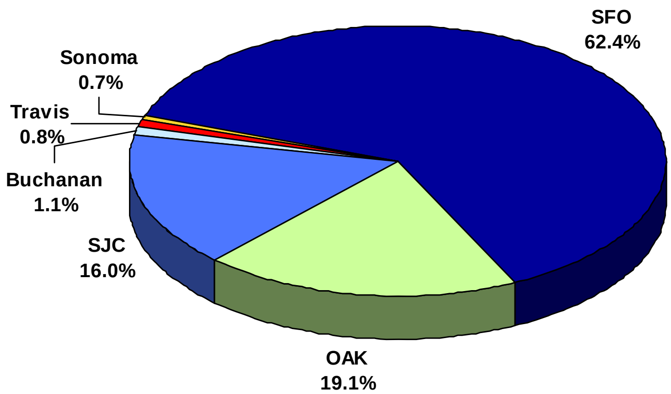


Figure 5-3: Forecast Passengers by Airport, Internal Alternate Airports Scenario



Airport	2035 Passengers (millions)
SFO	63.1
OAK	19.3
SJC	16.2
Buchanan	1.1
Travis	0.8
Sonoma	0.7
Total Bay Area	101.3

5.1.4 Alternate External Airports Scenario

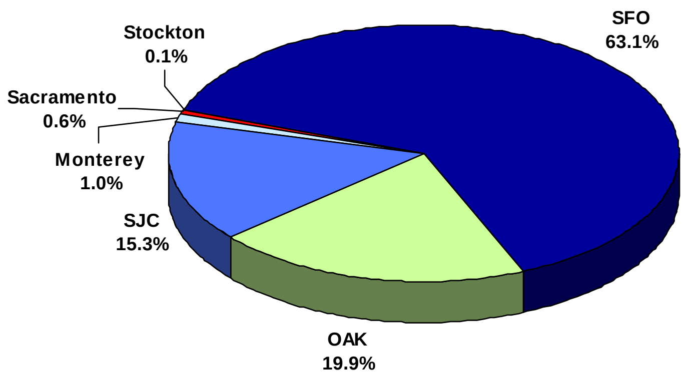
In 2006, about 9 percent of domestic origin-destination (O&D) passengers[2] using one of the primary Bay Area airports originated their trip from outside the 9-county Bay Area region. These passengers were attracted to the Bay Area airports either because they provided the flight they needed or because of better service options (i.e., more departures and/ or lower air fares compared to airports in their area). In this "External Secondary Airports Scenario", three airports – Sacramento International Airport (SMF), Monterey Peninsula Airport (MRY) and Stockton Metropolitan Airport (SCK) – were evaluated to assess the future ability of these airports to recapture local passengers who currently bypass these airports and instead choose to fly from a Bay Area airport. As airlines expand air service offerings at these airports over time, passengers from outside the region are expected to become less dependent on Bay Area airports for air service. As in the Internal Secondary Airports Scenario, the effectiveness of this scenario depends on the airlines' interest in developing new air services at these airports and local marketing efforts. Forecast passengers by airport in the External Alternate Airport Scenario are presented in Figure 5-4.

- A number of new non-stop services were evaluated for each airport, resulting in an estimated diversion of 1.7 million air passengers from Bay Area airports in 2035.

[2] A Bay Area O&D passenger began or ended their air journey at one of the Bay Area airports. Bay Area O&D passengers exclude passengers that connected, or changed planes, at one of the Bay Area airports.

- New airline service at the out-of-region airports would reduce flight activity at Bay Area airports by 15,600 annual flights, with a reduction of about 4,000 flights a year at both SFO and OAK. The most noteworthy diversion would occur at SJC, with a reduction of 7,500 annual operations, due primarily to improved air services at Monterey Airport.
- Total Bay Area airline passenger flights would be reduced by 1.4%.

Figure 5-4: Forecast Passengers by Airport, External Alternate Airports Scenario



Airport	2035 Passengers (millions)
SFO	63.9
OAK	20.2
SJC	15.5
Monterey	1.0
Sacramento	0.6
Stockton	0.1
Total Bay Area	101.3

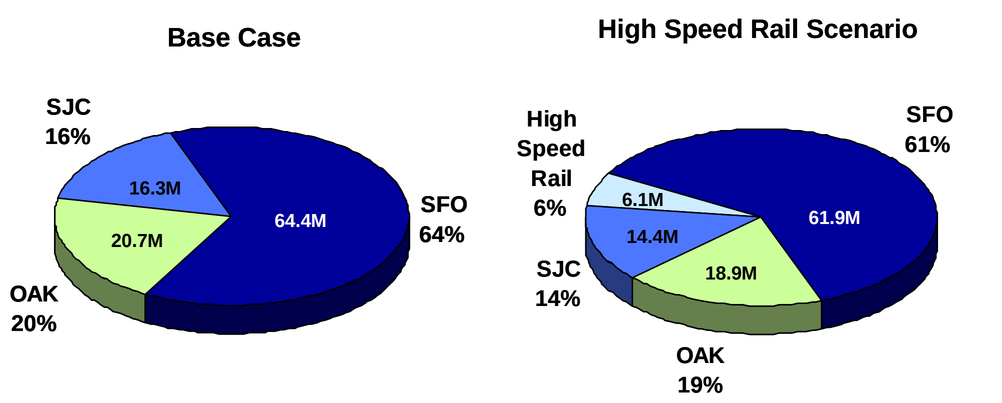
5.1.5 High Speed Rail Scenario

The "High-Speed Rail Scenario" assesses the potential future diversion of air passengers from the Bay Area airports to the planned California High-Speed Rail (HSR) system. The initial phase of the 220-mph HSR system, which has received partial funding from state and federal sources, would be constructed between downtown San Francisco and Los Angeles/Anaheim and could potentially serve air passengers who would normally fly from the Bay Area to Los Angeles, Burbank, and Orange County. The initial HSR system would indirectly serve passengers in the Bay Area-San Diego and Ontario markets who could connect to the HSR service using conventional train service or automobiles. In a subsequent phase, the HSR would be extended from Los Angeles to San Diego, with better access to Ontario, potentially diverting more air passengers in the Bay Area-San Diego and Ontario markets.

Over 100 trains per day would travel between the Bay Area and Southern California in 2035 with a travel time to Los Angeles of about 2.5 hours. The planned HSR alignment enters San Jose from the south and travels up the Peninsula to downtown San Francisco. The California cities that would be served by HSR include 5 of the top 15 Bay Area domestic air passenger markets and 26% of all domestic passengers served from the three Bay Area airports (based on 2007 passenger statistics). Air passengers would be diverted to HSR by a combination of factors, such as frequent service, competitive fares, reliability, and proximity to their final destination. However, the effectiveness of this Scenario would also be strongly influenced by future airline decisions, as the airlines could lower their fares to retain air passenger share and/or increase the number of flights to California cities using smaller aircraft (potentially, negating some of the anticipated runway capacity benefits).

- Using information developed by the California High Speed Rail Authority, about 6 million annual air passengers would be diverted to HSR in 2035, or about 6% of total Bay Area air passengers in 2035. (See Figure 5-5)
- All three Bay Area airports would experience some air passenger diversion to HSR, estimated at 2.4 million air passengers from SFO, 1.9 million air passengers from SJC and 1.8 million air passengers from OAK. Air passengers are diverted from OAK to HSR at a lower rate than the other airports because these passengers have less convenient access to HSR from the East Bay.
- Total passengers would be reduced 11.9% at SJC, 8.6% at OAK, and 3.7% at SFO.
- Total Bay Area aircraft operations would decrease by 6.1%.

Figure 5-5: Comparison of Forecast Passengers by Airport
Base Case vs. High Speed Rail, 2035



5.1.6 Demand Management

The "Demand Management Scenario" analyzes the use of administrative measures to reduce projected aircraft delays and is focused on SFO because it has the most significant delay problem. A list of potential demand management strategies is presented in Table 5-1. Demand Management involves the use of regulatory or administrative measures to control or influence the number of aircraft flights at an airport, and it is assumed that these strategies would not affect the number of passengers using the airport. Currently, the most common form of demand management is the use of slot controls to limit the number of aircraft take-offs and landings to a level below an airport's hourly capacity. In the past, the FAA has imposed slot controls at highly congested airports, like New York La Guardia, Washington's National Reagan Airport, and New York JFK Airport, to manage delays.

Table 5-1: Potential Demand Management Measures

- **FAA Slot Controls** *(DCA/LGA)*
- **FAA Negotiated Caps** *(ORD/JFK/EWR)*
- **Perimeter Rules** *(LGA/DCA/Love Field)*
- **Passenger Caps** *(Orange County)*
- **Direct Negotiations Between the Airport and the Airlines**
- **Limits on Available Gates** *(LAX)*
- **Minimum Aircraft Size Rules**
- **Peak Period Pricing** *(BOS)*
  - *Explicitly Permitted at Congested Airports by New U.S. DOT Rates and Charges Policy*

More recently, new U.S. Department of Transportation (DOT) policy allows certain "congested" airports to enact landing fees that are partly based on the level of congestion at the airport rather than based solely on the landing weight of aircraft. Administrative measures, such as differential pricing between peak and off-peak periods, can reduce congestion and delay by creating financial incentives for airlines to: (1) spread flight activity more evenly across the day, and (2) increase aircraft size (i.e., encourage up-gauging) to accommodate more passengers with fewer fights. Previous attempts by airport operators to implement demand management have largely been unsuccessful due to legal and other issues, and while some airports are exploring congestion pricing, no airport has tried to use this policy as it is still relatively new.[3]

[3] However, the Massachusetts Port Authority has implemented a pre-emptive demand management program at Boston Logan International Airport to address potential future conditions of airline overscheduling.

The study evaluated several diverse types of demand management approaches at SFO to estimate their impact on projected delays in 2035. The ultimate decision as to which specific strategy or combination of strategies to pursue would be made by SFO in consultation with the FAA. The various components selected for evaluation were:

- Using buses instead of small aircraft for short distance airline feeder flights from Sacramento, Monterey and Modesto
- Shifting some scheduled airline flights out of the hours at the beginning and end of the 8 a.m. to 2 p.m. period of the day --- the timeframe in which the greatest amount of delay is generated
- "Upgauging" the size of aircraft serving SFO in 2035 to a minimum of 100 seats; this primarily affects operations by Regional Jets which operate with 50-70 seats per aircraft
- Limiting the number of small business jets allowed to land and take off in the peak period by establishing a reservation system
- Also, limiting the number of general aviation operations to the number using the airport in 2007; this assumes future growth in business jet operations would be shifted to the region's major general aviation airports by providing new facilities and enhanced navigation aids.

Based on these assumptions, the Demand Management Scenario would reduce annual aircraft operations at SFO by 23,000 flights (4.3 %) in 2035.

5.1.7 New ATC Technologies Scenario

This Scenario analyzes the potential impacts of technical advancements in the FAA's air traffic control system on the projected delays at the Bay Area airports. NextGen, the FAA's next generation air traffic management system, will utilize satellites and enhanced aircraft avionics for precise navigation as well as other technologies and will significantly improve airspace and runway capacity in the United States.

Major elements of NextGen that would improve airport capacity include technologies to reduce the spacing between aircraft landing and taking off at airports[4]; new departure and arrival routes to remove existing bottlenecks in the airspace; expanded

[4] For safety reasons separations between arriving and departing aircraft are required so that a trailing aircraft can avoid the wake turbulence created by the leading aircraft. Future wake vortex avoidance technologies can reduce the required aircraft separation distances and thereby increase runway capacity by increasing the arrival acceptance rate.

weather conditions in which pilots can essentially fly their planes as if they were operating in good weather; improved sequencing of arriving aircraft to optimize airport arrival capacity, and improved navigation precision so that aircraft arrive over fixed points at specific times. (See Table 5-2)

Table 5-2: NextGen ATC Technologies and Procedures

Improvement	New Technology/Procedure
Reduce Required Aircraft Separations	Wake Vortex Advisory System (WVAS) Airport Surface Detection Equipment (ASDE-X)
Increase Precision of Aircraft Tracking	Required Navigational Performance (RNP) Increase precision of ATC spacing of aircraft Center-TRACON Automation System (CTAS)
Extend Weather Envelope When Procedures Can be Used	Enhanced Simultaneous Offset Instrument Approach (SOIA) Cockpit Display of Traffic Information Assisted Visual Separation (CAVS) IFR Paired Approaches

The new ATC technologies will enhance capacity at all of the Bay Area airports, but SFO is expected to be the major beneficiary. SFO is forecast to have severe delays by 2035, and the newer technologies could overcome some of the limitations imposed by weather patterns unique to SFO and the close spacing of its runways.

The ATC Technology Scenario is based on a specific set of assumptions regarding technologies and the timing of when they would be deployed. However, there are a number of barriers to full implementation of the new ATC technologies. First, new ATC technologies typically take at least a decade for FAA certification and user acceptance. Airlines and other users may still be reluctant to pay for new equipment unless they can clearly see the economic benefits. In addition, pilots and air traffic controllers must undergo training and must accept the new systems as completely safe. Also there are unresolved questions about the amount and sources of funding needed to fully implement NextGen. In terms of the Bay Area's situation, there will be a need for a focused advocacy effort to ensure that the Bay Area is an early recipient of these new technologies.

- The ATC Scenario would not affect the distribution of air passenger traffic between the three Bay Area airports or the number of airline and general aviation operations forecasted for these airports.
- The ATC Scenario would, however, be a virtual requirement for SFO to handle the projected level of 2035 demand in the Base Case (64 million annual air passengers).

5.2 Combined Scenarios

Each of the above Scenarios was evaluated individually to determine how it performed in relation to the various study goals. The results of this analysis were discussed at a series of public meetings throughout the Bay Area. Following the public meetings, the staff of the Regional Airport Planning Committee recommended a set of new Scenarios combining elements of the six individual scenarios above. The purpose in combining these elements into new Scenarios was to create a set of Scenarios that would be even more effective in addressing the study goals.

Three (3) new Scenarios were defined for further review and include different elements of the six original Scenarios. Two Scenarios (Scenarios A and B) were evaluated using the same goals and performance measures as in the original analysis. Scenario C represents a conceptual strategy for serving demand under the High Forecast, but was not evaluated in detail. Given the uncertainty with the implementation timeframe for HSR, Scenarios A and B were evaluated both with and without HSR as one of the elements. Some of the assumptions made in the New ATC Technologies Scenario may be very optimistic in terms of delivery within the timeframe of this study, so the new Scenarios also scale back the ATC technology improvements to those which are most advanced in their engineering development and, therefore, most likely to occur within the study's planning horizon. Forecast passengers for Scenarios A and B without HSR are presented in Figure 5-6, and forecast passengers for Scenarios A and B with HSR in Figure 5-7.

5.2.1 Combined Scenario A

This Scenario is similar to the Traffic Redistribution Scenario in terms of the distribution of air passengers among the three Bay Area airports, but it also includes elements of the New ATC Technologies Scenario and the SFO Demand Management Scenario.

- **Airport Passengers:** The same air passenger distribution as in the Traffic Redistribution Scenario was assumed, which would result in OAK and SJC serving larger shares of domestic flights and passengers.
- **New ATC Technologies:** The specific technology assumptions at each airport are: improved SOIA at SFO (expands the weather conditions in which paired aircraft approaches can be made to SFO's closely spaced runways), a relocated Instrument Landing System glide slope antenna for OAK's Runway 11 (improves airport capacity during Southeast traffic flow conditions); new RNP/RNAV routes for OAK and SFO (reduce early morning departure conflicts between OAK and SFO by enabling closer

spacing of aircraft departing on the same routes from each airport), and implementation of Center TRACON automation (a program used by air traffic controllers to optimize spacing between arriving aircraft at an airport).

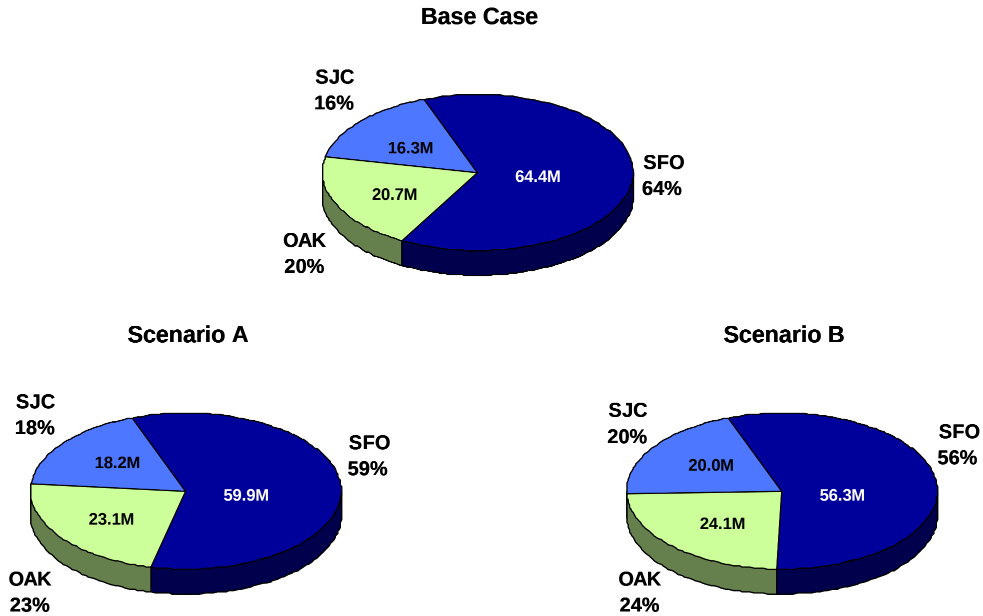
- **Demand Management:** Scenario A includes the same set of assumptions as in the original Demand Management Scenario for SFO.

5.2.2 Combined Scenario B

This Scenario is the same as Scenario A in terms of new ATC Technology improvements, but adds additional strategies:

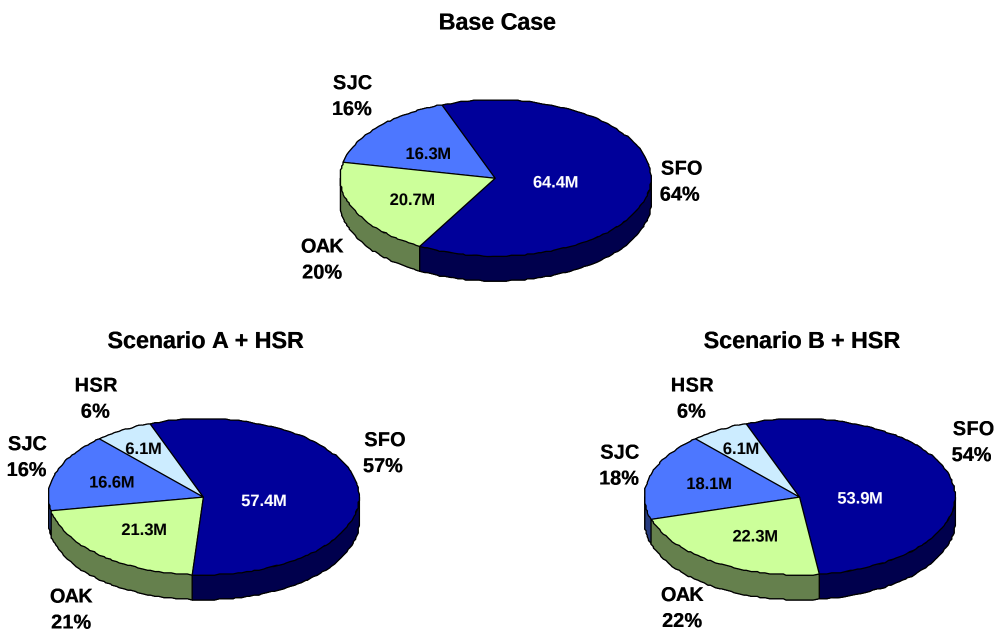
- **Traffic Redistribution:** Domestic passenger shares are increased even further for OAK and SJC (35% for OAK and 32% for SJC), based on an analysis of current markets where there is competitive nonstop service at each airport. This reduces airline flights at SFO even more than Scenario A. Local air passengers with ground origins nearer to OAK and SJC would be able to use these airports instead of traveling further to obtain comparable airline services at SFO. While airline delays at SFO would contribute to redistribution of air passengers (as in Scenario A), Scenario B assumes that the impetus for airlines to shift services to OAK and SJC would also occur through more extensive use of demand management at SFO, such as congestion pricing or more stringent requirements imposed on airlines to upgauge the size of their aircraft. Alternatively, the FAA could impose capacity controls at SFO if degraded efficiency begins to have an adverse impact on the national airspace system by creating delays at other U.S. airports.
- **Expanded Service at Sonoma County Airport:** Scenario B assumes that Sonoma County Airport would handle more passengers as in the Internal Alternate Airports Scenario (i.e., approximately 700,000 additional air passengers in 2035). This would make the airport a convenient option for more air passengers living in and around the Santa Rosa area as these passengers could avoid making longer distance trips to SFO or OAK for air service.
- **Demand Management:** New elements would be added to the original Demand Management Scenario to address delays, including a greater "smoothing" of flights in the 8 a.m. to 2 p.m. time window to try and limit the maximum demand to 75 operations per hour. These more restrictive elements may also contribute to airlines electing to expand service at OAK and SJC.

Figure 5-6: Comparison of Forecast Passengers by Airport - *Base Case, Scenario A and Scenario B, 2035*



Note: In Scenario A, 0.2M passengers would be accommodated on bus services to and from SFO.
In Scenario B, 0.2M passengers would be diverted to bus services and 0.7M additional passengers would use Sonoma County Airport.

Figure 5-7: Comparison of Forecast Passengers by Airport - *Base Case, Scenario A + HSR, and Scenario B + HSR, 2035*



Note: In Scenario A + HSR 0.2M passengers would be accommodated on bus services to and from SFO.
In Scenario B + HSR, 0.2M passengers would be diverted to bus services and 0.7M additional passengers would use Sonoma County Airport.

5.2.3 Combined Scenario C (High Forecast of Demand)

Because of the inherent uncertainty in the forecasts as discussed above, there is a possibility that Bay Area air passenger, air cargo and general aviation traffic could grow faster than estimated in the Base Case and create additional pressure on airport runways. Forecast passengers for "Combined Scenario C" are presented in Figure 5-8. In this situation, a new combination of strategies would be required in 2035 to handle the additional airline and general aviation flights. A conceptual strategy for handling this level of demand is outlined below; and as mentioned previously, no detailed analysis for the various goals was performed for this set of conditions.

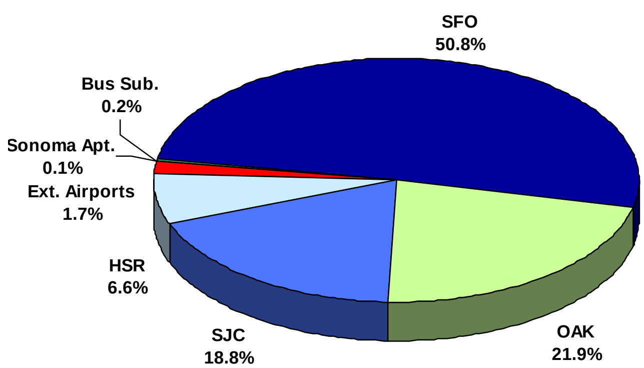
- OAK and SJC would need to handle an even greater share of regional air passenger demand (28 million passengers and 24 million passengers, respectively). This level of demand could be accommodated on their existing runways and with new NextGen ATC technologies.
- SFO would need to serve approximately 65 million passengers, a level slightly higher than in the Base Case. Air cargo flights and general aviation activity would also increase. In order to serve this level of demand without extreme delays, the full set of NextGen ATC technologies would be required to enable paired aircraft arrivals on SFO's closely spaced runways in nearly all poor weather conditions.
- SFO would still require a robust demand management program to limit the number of aircraft operations in the most delay-prone hours and to encourage airlines to shift more flights to OAK and SJC.
- High Speed Rail would be an essential component of the Bay Area strategy in this Scenario, essentially functioning as a "fourth" regional airport. HSR would need to divert approximately 8 million air passengers traveling between the Bay Area and Central/Southern California markets.
- Sonoma County Airport would need to handle additional local air passenger demand (approximately 900,000 air passengers compared to 700,000 in Scenario B).
- The Monterey, Sacramento, and Stockton airports would also need to expand their airline service choices to attract 2 million local air passengers who would otherwise use the three primary Bay Area airports (as evaluated in the External Alternate Airports Scenario).
- The full range of NextGen ATC technologies under development by the FAA would be required in Scenario C. In addition to creating new capacity, these technologies would enable greater use of Continuous Descent Approaches to all three Bay Area airports, which would provide reductions in airport noise

and aircraft emissions. (It is important to note that enabling paired approaches to parallel runways as close as those at SFO under instrument weather conditions is not currently part of planned NextGen capabilities, although the technologies needed to develop this capability (i.e., ADS-B In and Cockpit Display of Traffic Information (CDTI) are included in planned NextGen capabilities.)

While the above strategies could theoretically serve the High forecast of 2035 demand, the same caveats for the original Scenarios also apply to Scenario C, such as the fact that a major redistribution of airline traffic among the three Bay Area airports may be difficult to achieve. Furthermore, HSR or new ATC technologies may not be available in the timeframe of the study, or may be scaled back due to funding issues. Therefore, there may be a need for the Bay Area to review other contingency strategies that are currently not under consideration. These would be evaluated later at an appropriate time:

- Additional airline gates at SJC (currently limited to 40 gates by local policy)
- Other "upland" airport alternatives: further examination of Travis AFB, Napa County Airport, Buchanan Field, or Byron Airport (in eastern Contra Costa County)
- Possible new runways at OAK or SFO

Figure 5-8: Forecast Passengers - *Scenario C, 2035*



Airport	2035 Passengers (millions)
SFO	65.0
OAK	28.0
SJC	24.0
HSR	8.4
External Airports	2.2
Sonoma County Airport	0.9
Bus Substitution	0.2
Total Bay Area	128.8

Forecasts of aircraft operations by airport and Scenario are presented in Exhibit 4 of the Appendix.

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6 RESULTS OF GOALS ANALYSIS

6.1 INTRODUCTION

As described in Section 2, the study established a number of Goals, with specific performance measures for each Goal. Each of the original and new combined Scenarios A and B was evaluated using these performance measures. This section provides an assessment of which Scenarios perform the best for each Goal by comparing the performance to the Base Case Scenario and to each other. For additional clarity, the Scenarios are ordered from the most effective to least effective relative to the Base Case.

6.2 SUMMARY OF SCENARIO PERFORMANCE

6.2.1 Reliable Runways

- The level of acceptable average annual aircraft delay was established as 12-15 minutes. SFO is the only Bay Area airport that will not be able to achieve this level of delay in the Base Case in 2035.
- OAK may experience early morning departure delays due to conflicts with SFO early morning departures on common routes. New airspace procedures (RNP/RNAV routes) can help resolve these conflicts.
- Delays at SFO could reach critical levels after 2020 under the Baseline forecast, increasing from an annual average 7 minutes (2007) to over 20 minutes in 2035 (Baseline).
- Improved ATC technologies (under development), new demand management programs, or a new California High Speed Rail system would mitigate SFO delays and could change the timeframe in which delay problems are likely to occur. (See Table 6-1)
- See Exhibit 10 in the Appendix for projected average annual delays at SFO and average delays during the peak 3 hours.

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Table 6-1: Estimated Impact of Scenarios on Reliable Runways Goal

Scenario	Avg Aircraft Delay at SFO (minutes)	Pct Change vs. Base Case
2007	5.7	
Forecast 2035		
Base Case	21.0	
Scenario B with HSR	5.3	-74.8%
Scenario A with HSR	6.4	-69.8%
Scenario B (no HSR)	6.7	-68.2%
Scenario A (no HSR)	8.1	-61.4%
New ATC Technologies	9.1	-56.8%
Traffic Redistribution	15.0	-28.9%
High Speed Rail	16.8	-20.3%
Demand Management	17.2	-18.4%
Alternate Internal Airports	19.4	-7.7%
Alternate External Airports	20.8	-1.0%

- For Scenario C, it was estimated that SFO’s average annual aircraft delay would be about 10 minutes in 2035 (acceptable range). This is due to the benefits of new ATC technologies combined with a demand management program and significant traffic redistribution, enabling the airport to handle the high runway activity levels associated with this Scenario.

6.2.2 Healthy Economy

- Because an efficient airport system is important to the economy, the performance measure for this goal is the average minutes of runway delay per flight.

Table 6-2: Estimated Impact of Scenarios on Healthy Economy Goal

Impact	Scenarios
High	Scenarios A&B with and without HSR New ATC Technologies
Medium	Traffic Redistribution High Speed Rail Demand Management
Low	Alterante Internal Airports Alternate External Airports

6.2.3 Good Passenger Service

- The quality of air passenger service, measured in flights per capita in the top 15 Bay Area air travel markets, is expected to remain about the same between now and 2035.
- The number of flights provided in each major air travel market is largely a function of airline decisions, but the Scenarios evaluated in this study will have some effect on total flights.
- HSR would be a substitute for airline flights, and because of the high frequency of train service planned for cities in the California Corridor, it would effectively increase the number of "flights" (i.e., counting train frequencies as flights) to some of the Bay Area's largest air travel markets. Thus, Scenarios which include HSR perform the best for this Goal. (See Table 6-3)
- The Scenario which has the next greatest impact on air passenger service would be Alternate Internal Airports, since the smaller planes used to serve these markets add frequency, resulting in more flights per capita.
- The Traffic Redistribution Scenario does not produce many additional Bay Area flights as plane sizes for the markets served are roughly comparable between SFO and OAK and SJC.

- The total number of airline flights is not affected by the ATC Technology Scenario and is only marginally affected by the Demand Management Scenario.

Table 6-3: Estimated Impact of Scenarios on Good Passenger Service Goal

Scenario	Annual Departures in Top Markets per 10,000 Bay Area Residents	Pct Change vs. Base Case
2007	263	
Forecast 2035		
Base Case	262	
Scenario B with HSR	302	15.2%
Scenario A with HSR	291	11.0%
High Speed Rail	288	9.6%
Alternate Internal Airports	279	6.2%
Scenario B (no HSR)	277	5.6%
Scenario A (no HSR)	266	1.4%
Traffic Redistribution	265	1.1%
Demand Management	263	0.1%
New ATC Technologies	262	0.0%
Alternate External Airports	256	-2.6%

Note: based on top 15 domestic O&D markets and includes HSR frequencies for scenarios that include High Speed Rail.

6.2.4 Convenient Airports

- All things being equal, air passengers generally prefer to use the closest airport. Ground access distance, time, and cost were estimated for each Scenario.
- The discussion below highlights the average distance air passengers travel to reach an airport (or access HSR) in 2035. Additional information on average travel time and costs can be found in Exhibits 11 and 12 in the Appendix. Average air passenger travel time is projected to increase between 2007 and 2035 due to rising congestion and slower speeds on the regional highway network (which affects the large number of air passengers using personal cars, taxis, rental cars, shuttles, and buses to reach the airports).
- For the Base Case Scenario, there would be some degradation in airport access convenience compared to today as a larger share of Bay Area air passengers have to travel longer distances to get the flights they need at SFO.
- The Alternate Internal and External Airports Scenarios perform well because these airports provide more flights closer to where air passengers live and

work (i.e., passengers have opportunities to use the Sonoma County, Travis AFB, Buchanan, Sacramento, Stockton and Monterey airports as opposed to traveling to a more distant airport). (See Table 6-4)

- The Traffic Redistribution Scenario has the same effect on access convenience by dispersing airline service to OAK and SJC, resulting in shorter travel distances for local air passengers who reside closer to these airports.
- With HSR, air passengers would also experience more convenient access as new HSR stations would be closer to their point of origin compared to traveling to an actual airport for a flight.
- Neither Demand Management nor New ATC Technologies would have any effect on air passenger ground access distances.

Table 6-4: Estimated Impact of Scenarios on Convenient Airports Goal

Scenario	Avg. Distance to Airports (miles)	Pct Change vs. Base Case
2007	29.34	
Forecast 2035		
Base Case	30.10	
Scenario B with HSR	28.39	-5.7%
Alternate Internal Airports	28.84	-4.2%
Alternate External Airports	28.93	-3.9%
Scenario A with HSR	29.02	-3.6%
Scenario B (no HSR)	29.09	-3.3%
High Speed Rail	29.39	-2.3%
Traffic Redistribution	29.72	-1.2%
Scenario A (no HSR)	29.72	-1.2%
New ATC Technologies	30.10	0.0%
Demand Management	30.10	0.0%

Note: Includes access distances to internal alternate airports and high speed rail train stations.

6.2.5 Climate Protection

- Greenhouse Gas emissions from aircraft (mainly CO^2) are projected to increase 49% to 66% between 2007 and 2035, depending on the Scenario. Airlines have acquired new, more fuel efficient aircraft, but some of the more significant fuel-saving technologies have already been put in place in their existing fleets. While some continued improvement in aircraft fuel efficiency is expected over the forecast period, the increase in aircraft operations is expected to offset any fuel efficiency gains. International efforts to control the growth in GHGs from aviation are being led by the International Civil Aviation Organization (ICAO), an agency of the United Nations.

- In 2035, greenhouse gas emissions from aircraft operations in the Bay Area airspace will contribute about 83% of the estimated CO^2 compared to 17% from air passenger vehicles.
- The Scenario with the greatest impact on aircraft GHGs is HSR, because it eliminates airline flights as air passengers switch from plane to rail, and because HSR is more efficient on a per passenger-mile basis than aircraft for short intra-state trips.
- The Traffic Redistribution Scenario and Combined Scenarios A and B reduce aircraft produced emissions by lowering taxiing delays at SFO. Combining the Traffic Redistribution Scenarios with HSR would result in the largest GHG reductions.
- While the trend in aircraft-generated GHGs appears to be upward, there are ways in which aircraft GHGs can be reduced that have not been factored into the GHG estimates. Examples of ways GHGs could be reduced include: use of biofuels in jet engines (currently being developed), flying slower to conserve fuel, deployment of NextGen ATC technologies (which would allow aircraft to fly more direct routes between airports and save fuel), and conducting Continuous Descent Approaches at Bay Area airports (which would reduce fuel consumption and emissions by an estimated 1-3% if all aircraft could use this type of fuel efficient approach path for landings).
- GHGs from air passenger vehicles (private cars, taxis, airport shuttles, etc.) will account for a declining share of Scenario GHGs as federal fuel economy standards gradually improve the overall fuel efficiency of all types of passenger vehicles. Air passenger vehicle GHGs will shrink from 22% of combined aircraft and vehicle GHGs in 2007 to 16% in 2035. Also, Scenarios that reduce ground access travel to airports, such as Scenarios A and B, will contribute to reduced emissions. Scenario B with HSR will reduce Vehicle Miles of Travel (VMTs) by roughly 5% compared to the Base Case.

Table 6-5: Estimated Impact of Scenarios on Climate Protection Goal

Scenario	Daily Metric Tons of CO^2	Pct Change vs. Base Case
2007	7,435	
Forecast 2035		
Base Case	11,378	
Scenario B with HSR	10,334	-9.2%
Scenario A with HSR	10,391	-8.7%
High Speed Rail	10,501	-7.7%
Scenario B (no HSR)	10,837	-4.8%
Scenario A (no HSR)	10,897	-4.2%
Traffic Redistribution	10,949	-3.8%
Alternate External Airports	10,962	-3.7%
Alternate Internal Airports	11,168	-1.9%
Demand Management	11,228	-1.3%
New ATC Technologies	11,320	-0.5%

Note: Includes emissions from aircraft and passenger ground access vehicles.

6.2.6 Clean Air

- The two air pollutants evaluated were emissions of Nitrogen Oxides (NOx) and Volatile Organic Compounds (VOCs), which are produced by both aircraft and air passenger vehicles. These pollutants combine to form ozone, and VOCs contain some toxic air contaminants. Aircraft engine emissions are regulated by the Environmental Protection Agency (EPA) in cooperation with ICAO. Prior regulatory actions have produced significant reductions in emissions of VOCs, NOx (the most recent new regulation), and particulates (i.e., smoke from engines). Similar to the GHG emissions, the projected increase in aircraft operations offsets any reduction in emissions from improvements in the fuel efficiency of aircraft and air passenger ground access vehicles.
- Total air emissions are projected to increase 26% to 44% between 2007 and 2035, depending on the Scenario.
- In 2035, aircraft will be responsible for 97% of pollutants and air passenger vehicles for only 3%.
- The ranking of Scenarios is virtually identical to that for GHGs.
- Additional measures that were not factored in to the estimates, but could reduce future emissions include: providing electrical power for aircraft at the

gate, use of biofuels in aircraft engines, towing aircraft to runway or taxiing aircraft with a single engine, and new ATC technologies that enable Continuous Descent Approaches at airports. All airport ground support equipment is assumed to be electrified by 2035.

- Despite increasing vehicle miles of travel (VMT) to airports, emissions from air passenger vehicles will actually decrease by 76% between 2007 and 2035 due to the tailpipe emission controls mandated by the California Air Resources Board and the increasing numbers of hybrid and all electric vehicles.

Table 6-6: Estimated Impact of Scenarios on Clean Air Goal

Scenario	Daily Metric Tons of VOC and NOx	Pct Change vs. Base Case
2007	16.7	
Forecast 2035		
Base Case	23.9	
Scenario B with HSR	21.0	-12.5%
Scenario A with HSR	21.1	-11.9%
High Speed Rail	21.5	-10.2%
Scenario B (no HSR)	21.9	-8.4%
Scenario A (no HSR)	22.1	-7.8%
Traffic Redistribution	22.2	-7.3%
Demand Management	22.7	-5.2%
Alternate Internal Airports	22.7	-5.0%
Alternate External Airports	22.9	-4.4%
New ATC Technologies	23.7	-1.1%

Note: Includes emissions from aircraft and passenger ground access vehicles.

6.2.7 Livable Communities

- Airport noise levels are measured using the Community Noise Equivalent Level (CNEL). The State airport standard is 65 CNEL, meaning that no incompatible development (e.g., residential or homes that have not been sound insulated) should be located inside this contour due to unacceptable levels of noise in the living environment. The population exposed to 65 CNEL or higher has been estimated for each airport in each Scenario and then combined into a total regional population as shown in Table 6-7. (Also, see Exhibit 13 in the Appendix for population inside the 55 CNEL noise contour, which encompasses a larger area where noise complaints can originate).

- Total regional population inside the 65 CNEL airport noise contour is estimated to increase by 74% to 93% between 2007 and 2035, depending on the Scenario, due to increasing numbers of aircraft operations at all airports. The most current FAA noise regulations for newly manufactured aircraft are not expected to produce a significant impact on the average noise of the overall airline fleet as many of the most potent technological advances have already been incorporated into existing aircraft models.
- It is important to note that many homes in the airport noise impact areas have already been sound insulated through airport and FAA- funded programs and are thus deemed noise compatible under the State airport noise standards; overall some 18,000 Bay Area homes around the three Bay Area airports have received sound insulation treatment, with 15,000 of these homes being located around SFO.
- Of the 2035 regional population impacted by noise above 65 CNEL, 87 % (Scenario B) to 92% (Base Case) is located around SFO.
- Population projections developed by ABAG in consultation with local governments assume there will be additional population added in noise-impacted areas around SFO and SJC (this study used ABAG's 2007 Focus Growth projections, as they were the latest available at the time). Part of the increase in population is due to new State requirements to address global warming from the land use side, which steers some of the additional population to areas around transit hubs, some of which are located near airports. Compared to the 2007 population, the 2007 Focus Growth projections for 2035 show there would be an increase in population of 9,837 (High Speed Rail) to 12,358 (Scenario B), or 23% to 28% higher depending on the Scenario (see Table 6-7).
- Of the original Scenarios analyzed, HSR would have the greatest impact on reducing noise in the airport vicinity by lowering the number of flights at each airport.
- Because a large portion of the regional population exposed to 65 CNEL or higher lives around SFO, shifting more domestic flights from SFO to OAK and SJC would lower noise exposure around SFO and regionally (because the decrease in population exposure around SFO is greater than the increase in population exposure around OAK and SJC). SJC would experience slightly higher exposure (600 to 1,700 more people), while the population increase around OAK would be minimal.

- Combining traffic redistribution with HSR would have the largest impact on reducing regional population exposed to airport noise (there would also be population adjacent to the HSR line exposed to train noise, but these impacts were not included due to methodological complexities with estimating population exposure due to air passengers riding HSR trains).

Table 6-7: Estimated Impact of Scenarios on Livable Communities Goal

Scenario	2007 Population in 65 CNEL	Pct Change vs. Base Case	*2035 Population in 65 CNEL*
2007	23,380		
Forecast 2035			
Base Case	45,049		*56,180*
Scenario A with HSR	40,730	-9.6%	*50,943*
Scenario B with HSR	41,593	-7.7%	*52,637*
High Speed Rail	42,665	-5.3%	*52,502*
Scenario A (no HSR)	42,813	-5.0%	*54,271*
Scenario B (no HSR)	43,866	-2.6%	*56,224*
Traffic Redistribution	44,002	-2.3%	*55,668*
New ATC Technologies	44,229	-1.8%	*55,209*
Alternate External Airports	44,433	-1.4%	*55,159*
Alternate Internal Airports	44,461	-1.3%	*55,474*
Demand Management	44,551	-1.1%	*55,599*

Note: Percent Change is based on 2007 population numbers.
2035 Populations are based on ABAG's 2007 Focus Growth Population Projections.

6.2.8 Summary

- As shown in the performance results presented in Table 6-8, Scenario B plus HSR ranks as the top Scenario for all the Goals, except Livable Communities where it is the second highest ranked Scenario.
- Scenario A plus HSR is the next highest ranked Scenario.
- If HSR is delayed in its implementation, both Scenario A (market driven traffic redistribution and modest ATC improvements) and Scenario B (market and demand management driven traffic redistribution and modest ATC improvements) would be able to contain aircraft delays at SFO to acceptable levels.
- Of the original six Scenarios, High Speed Rail performs the best overall in relation to the environmental goals.

- New ATC Technologies is the most effective of the original Scenarios in limiting aircraft delays at SFO, while the Alternate Airports Scenarios (both Internal and External) are the least effective.
- Scenarios A and B plus HSR have the most benefit in terms of limiting regional population exposed to airport noise; Scenario A (or A plus HSR) has a slightly greater benefit compared to Scenario B in this regard.
- Focus Growth projections would increase regional population exposure to airport noise, which may not be an intended outcome of these projections.
- Demand Management, as a standalone strategy, would not be sufficient to limit SFO's delays to acceptable levels.
- The major advantage offered by the Scenarios that include use of alternate airports is improved ground access convenience and more airline service overall for Bay Area residents.
- The Alternate Internal Airports Scenario also provides more flights per capita for Bay Area residents when compared to Scenarios A and B without HSR.
- The New ATC Technologies Scenario, as evaluated, does not have significant environmental benefits within the confines of the Bay Area airspace but would have significant environmental benefits when these technologies are implemented at the national level. These technologies would enable use of Continuous Descent Approaches at all Bay Area airports, which would produce some noise and emission benefits.
- While not part of the Goals analysis, there are a number of implementation issues associated with all the Scenarios, some of which are quite significant. The recommendations below address some of the major implementation issues that have been identified and which were discussed briefly in the description of the various Scenarios in Section 5.

Table 6-8: Summary of Scenario Performance Results

Scenario:	Goal: Economy	Reliable Runways	Good Service	Convenient Airports	Climate Protection	Clean Air	Livable Communities
Metric:	*Average Aircraft Delay*	*Average Aircraft Delay*	*Flight Frequency in Top 15 O&D Markets*	*Average Ground Access Time*	*Green House Gases (CO2)*	*Hydrocarbons (Nox+VOCs)*	*Population in 65 CNEL*
Traffic Redistribution	-28.9%	-28.9%	1.1%	0.6%	-3.5%	-7.2%	-2.3%
Internal Airports	-7.7%	-7.7%	6.2%	-2.5%	-1.8%	-5.0%	-1.3%
External Airports	-1.0%	-1.0%	-2.6%	-1.3%	-3.6%	-4.4%	-1.4%
High-Speed Rail	-20.3%	-20.3%	9.6%	0.3%	-7.8%	-10.3%	-5.3%
ATC Technologies	-56.8%	-56.8%	0.0%	0.0%	-0.5%	-1.1%	-1.8%
Demand Mgmt	-18.4%	-18.4%	0.1%	0.0%	-1.3%	-5.2%	-1.1%
Scenario A	-61.4%	-61.4%	1.4%	-1.5%	-4.2%	-7.8%	-5.0%
Scenario A+HSR	-69.8%	-69.8%	11.0%	-3.3%	-8.7%	-11.9%	-9.6%
Scenario B	-68.2%	-68.2%	5.6%	-3.5%	-4.8%	-8.4%	-2.6%
Scenario B+HSR	-74.8%	-74.8%	15.2%	-5.3%	-9.2%	-12.5%	-7.7%

Impact vs. Baseline	Improvement Criteria Aircraft Delay	Improvement Criteria All Other
High Impact	>= 50%	>= 10%
Medium Impact	15 to 49%	5 to 9%
Low Impact	< 15%	< 5 %

7 Issues and Recommendations

7.1 Issues Identified and Study Recommendations

As stated previously, Scenario B plus HSR ranks as the top Scenario for all the Goals, except Livable Communities and is therefore the recommended approach to satisfy projected aviation demand. In brief, Scenario B includes the key strategies listed below.

- Significant redistribution of air passenger traffic from SFO to OAK and SJC;
- Increased use of Sonoma County Airport to serve local air passenger demand;
- New Air Traffic Control Technologies that have a high likelihood of implementation;
- A robust Demand Management program at SFO; and
- High Speed Rail initial segment from San Francisco to Orange County (Scenario B could also meet regional aviation capacity needs if HSR is not implemented in the timeframe of the study)

Because of the inherent uncertainty in the forecasts as discussed previously, there is a possibility that Bay Area air passenger, air cargo and general aviation traffic could grow faster than estimated and create additional pressure on airport runways. The recommended strategy for handling this potentially higher level of aviation demand is Scenario C, which is described in detail in Chapter 5 and summarized as follows:

- Even greater redistribution of regional air passenger demand to OAK and SJC;
- Additional local air passenger use of Sonoma County Airport;
- More extensive use of advanced ATC technologies being considered as part of FAA's NextGen program;
- New airline services at airports outside the Bay Area to serve passengers who would otherwise use Bay Area airports;
- Advanced Demand Management program for SFO; and
- High Speed Rail (HSR would be an essential element of a strategy to serve higher than forecasted air passenger demand, and Scenario C would benefit from extension of the HSR system beyond Orange County to San Diego, as this could divert even more air passengers to HSR).

If the major strategies above do not come to fruition to the extent planned, then future updates of the RASPA will likely need to assess other approaches, possibly including new runway development.

A number of important issues have surfaced during the course of the study that could have a significant impact on the Bay Area's ability to achieve Scenario B and the related long-range planning goals for the Bay Area airport system. To call attention to these issues, the study Recommendations and suggested future work tasks are listed by issue.

Issue 1: Changing conditions which alter long-range planning assumptions

1. Regional aviation forecasts should be updated more frequently to respond to changing events in the aviation industry and to better inform future airport planning decisions; RAPC should regularly track factors affecting the air passenger and air cargo forecasts.
2. Regional agencies will use the latest RASPA forecasts[5] in any of their airport-related planning decisions (e.g., BCDC approvals, ABAG regional land use policies and plans, and MTC airport access improvements). Individual Bay Area airports should collaborate with RAPC when developing new forecasts for their airports, particularly in regard to assumptions about total regional aviation demand as well the share of regional air passenger and air cargo demand served at their airport.
3. RAPC should regularly track factors that affect airport runway capacity and delays; update information annually.

Issue 2: Lack of regional mechanisms to influence airline decisions about which airports to serve

1. Regional plans should support the airport passenger distributions in Scenario B, as this Scenario performs the best in relation to the Study Goals.
2. RAPC should explore new ways to engage the airlines in discussions concerning regional airport capacity issues and regional interests in expanding the share of traffic served by OAK and SJC.

[5] Currently Baseline/Scenario B.

3. Working with the Bay Area airports, RAPC could develop a list of underserved airline markets at OAK and SJC and use this in advocating for needed service improvements with the airlines.

4. RAPC could also work with the Bay Area airports and the local business community to develop a regional marketing program to expand use of OAK and SJC by Bay Area residents.

5. Increasing ground accessibility to OAK and SJC by highways and transit will be important to attracting more passengers to these airports. RAPC supports ongoing and future transit and highway improvements to increase their regional accessibility.

Issue 3: Difficulty implementing airport-originated demand management programs

1. Future airline agreements at SFO should not preclude use of congestion pricing approaches as allowed by the latest FAA policy.

2. SFO should continue to examine new demand management approaches that could be quickly implemented if there is a sudden onset of extreme delays (due to added airline flights and/or more frequent bad weather).

3. If SFO's demand management program does not contain delays to acceptable levels, the Bay Area should advocate for FAA intervention to manage these delays.

4. RAPC should monitor other airport demand management programs around the country to determine what programs are being implemented and their effectiveness.

Issue 4: Uncertainty regarding the timing and effectiveness of new ATC technologies

1. The FAA should provide regular updates to RAPC on the status of its NextGen program, including approximate timeframes for deployment of new technologies at Bay Area airports.

2. RAPC supports the use of incentive approaches by the FAA to encourage airlines to purchase NextGen technologies for their fleets.

3. Regional agencies should be more active in taking positions on federal aviation legislation affecting NextGen funding and delivery, particularly in regards to expediting NextGen in the Bay Area..

4. To increase the effectiveness of its NextGen advocacy, the Bay Area airports and regional agencies could form a larger national coalition with other regions experiencing major runway congestion problems (e.g., New York, Chicago, Los Angeles, etc.).

5. RAPC should support a study by the FAA of the Bay Area airspace to examine changes in operations and procedures that would be needed to maximize the benefits of NextGen technologies. The study should also identify any adverse airport or community environmental impacts resulting from changes to existing airport arrival and departure routes.

Issue 5: Uncertainty regarding future HSR plans and the effectiveness of HSR in diverting air passengers to rail

1. RAPC should continue to monitor future HSR developments, including any changes in assumptions about routes, fares, service levels, and implementation timeframe, as such changes would affect the conclusions reached in this study about HSR's effectiveness in addressing regional runway capacity and environmental issues.

2. RAPC should encourage discussions between the airlines and the California HSR Authority to examine the potential for joint ticketing arrangements, similar to the cooperative European model between airlines and HSR.

Issue 6: Uncertainty regarding the future role of some alternative airports

1. Air passenger or air cargo development at alternative airports will largely be initiated at the local level (as was done at Sonoma County Airport), and RAPC should work with the local government sponsors to determine how best to support their efforts.

2. RAPC encourages county Airport Land Use Commissions (ALUCs) and local jurisdictions to continue to maintain a high level of land use compatibility around all Bay Area airports, and particularly those evaluated in this study that have promise to serve some local air passenger demand in the future.

3. If regional air passenger and/or air cargo demand increases faster than currently forecasted, RAPC may wish to work with local jurisdictions to update the prior feasibility study for Travis AFB; this study should be conducted well in advance of any potential need for joint use of this facility

given the timeframe required to address some of the issues that would arise in connection with joint use.

4. RAPC should stay in close communication with Sacramento, Stockton, and Monterey airports and continue to involve these airports in the long-term planning of the Bay Area airport system.
5. Moffett Federal Airfield does not appear to be needed to serve the region's long-term air passenger demand; however, no other potential roles for Moffett Federal Airfield were evaluated (e.g., emergencies in response to a natural disaster, limited air cargo services, or as a general aviation reliever airport). Therefore its potential to serve in some regional aviation capacity should be protected until such studies are conducted.

Issue 7: Projected increase in community noise exposure around all airports (2007-2035)

1. Recognizing the substantial noise monitoring and noise exposure mitigation strategies Bay Area airports currently have in place, OAK, SFO, and SJC should continue to apprise RAPC about their latest approaches for working with communities to address existing and emerging noise issues.
2. Based on the initial assessment showing potentially significant increases in population exposed to airport noise levels of 65 CNEL and greater (2007 to 2035), Bay Area airports should use the more sophisticated noise modeling tools they have available to confirm noise trends out to 2035 when conducting future environmental studies and should address a broader range of noise metrics than were employed in this study.
3. Should these 2035 noise impacts prove significant, more detailed studies would be needed of potential mitigation strategies, including sound insulation of more homes, changes to runway operations, and changes to local land use plans.
4. Regional agencies should also review the contribution of the latest Focus Growth population projections to these estimated population increases and evaluate whether some of the population can be located in less noise-impacted areas.

Issue 8. Projected increase in criteria pollutants and GHGs

1. The Bay Area Air Quality Management District should provide periodic reports to RAPC on the amount of criteria pollutants (VOCs and NOx) and GHGs from aircraft operations at Bay Area airports (e.g., when updated emission inventories are prepared).
2. RAPC should monitor future regulatory and legislative changes at the federal and international level that could reduce these emissions and take supporting positions as appropriate.
3. The Bay Area airports should provide periodic updates to RAPC of their own initiatives to reduce on-airport air emissions from aircraft, ground service vehicles and transportation services to the airport.

8 Future Work Scope

8.1 Recommended Work Tasks

The recommendations in this latest RASPA update reflect the results of a large body of technical work as shown in the Appendix (Exhibit 18). However, to better address the issues and recommendations discussed in the previous section, the following additional work tasks are suggested. Achieving a significant redistribution of regional air passengers is central to the effectiveness of Scenario B, and perhaps the most difficult strategy to achieve due to the lack of control over airline route and fare decisions. Because of this, near term work by the regional agencies and airports should focus on further developing the suggested Work Tasks that most directly assist this strategy. To carry these suggested Work Tasks forward, more discussion will be needed in terms of scope, funding, and lead and supporting agency responsibilities.

Issue 1: Changing conditions which alter long-range planning assumptions

- **Forecast Tracking System** (High Priority). The forecast tracking system will enable early identification of trends that could lead to changes in the forecasts for air passengers, air cargo, and aircraft operations. The forecasts, both regional and by airport, would be adjusted more frequently rather than every 5-10 years as is the current norm. RAPC would collaborate with the Bay Area airports to determine when an adjustment is needed and the type of adjustment required (minor or major new update to the forecasts).
- **Multi-Region Air Passenger Survey** (High Priority). The survey would update the location of air passengers using all the airports in the Bay Area and surrounding regions (i.e., OAK, SFO, SJC, Sonoma County, Sacramento, Stockton, and Monterey), their reasons for selecting the particular airport they are currently traveling from, and their mode of access. This information is critical to forecasting the future passenger use of each airport in the larger nine-Bay Area county mega region and would assist airports with their airline marketing efforts. In addition, the new information could be used to develop an updated airport choice model for the Bay Area that incorporates both the ground access time and airline service characteristics into a computer model that predicts future airport use and choice of ground transportation mode (a tool that was not available for this study).

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Issue 2: Lack of regional mechanisms to influence airline decisions about which airports to serve

- **Regional Airport Marketing Program** (Medium Priority). RAPC would work with the three Bay Area airports and business community to develop enhancements to current marketing efforts that are underway to expand use of OAK and SJC, such as publicizing new airline service initiatives at these airports. The goal of the program would be to generate additional passengers for new airline services, and through the success of these services, create a climate for even further service additions.
- **Traffic Redistribution Monitoring Program** (High Priority)**.** The Forecast Tracking Report will assess the amount of air passenger redistribution that is occurring among the three Bay Area airports, including the share of air passengers served by each airport, the share of scheduled seats flown in the major air travel markets at each airport, and the fare differentials between airports in the major markets.
- **Airport Pricing Analysis** (Medium Priority). RAPC would further examine airline cost factors at each primary airport and determine the price differential necessary to affect a significant change in airline service between SFO and OAK and SJC (through landing fees and other airport costs). Pricing ,including congestion pricing, could be a key element of a traffic redistribution strategy.

Issue 3: Difficulty implementing airport-originated demand management programs

- **Congestion Tracking System** (High Priority). RAPC would develop a methodology and reporting system to measure how close each airport is to its estimated runway capacity as well as track flight delays.
- **Monitor Demand Management Developments at other Airports** (High Priority). RAPC staff would report on new approaches to demand management that are being tried at other airports around the country and their effectiveness.
- **Reliever Airport Strategy** (Low Priority). One element of a Demand Management strategy for SFO that was evaluated in the study was to shift the growth in corporate business jet operations from SFO to other Bay Area reliever general aviation airports. The purpose of this study would be to develop specific strategies for shifting corporate general aviation flights from SFO and other air carrier airports to the region's major general aviation facilities. The study would also look at airspace interactions and identify

certain airports where this growth should not be encouraged. The study would further assess facility and service needs and associated costs at each airport to accommodate increased corporate general aviation demand.

Issue 4: Uncertainty regarding the timing and effectiveness of new ATC technologies

- **Regional Airspace Study** (High Priority). This study is uniformly supported by all parties involved in this current analysis and is a necessary precursor for full deployment of NextGen at Bay Area airports. It would be conducted by the FAA (as in other regions of the country) and would look at key airspace interactions and sources of delay and determine what changes in airspace procedures would be needed to facilitate NextGen. The study would also identify short-term improvements that don't require the full suite of new NextGen technologies and that could be implemented more quickly.

Issue 5: Uncertainty regarding future HSR plans and the effectiveness of HSR in diverting air passengers to rail

- **Monitor High Speed Rail Developments** (Medium Priority). RAPC staff would work with the California High Speed Rail Authority to provide periodic updates to RAPC on the latest plans for the California High Speed Rail System, including various service factors and future discussions with the airlines concerning joint ticketing arrangements.

Issue 6: Uncertainty regarding the future role of some alternative airports

- **Travis AFB-Updated Feasibility Study** (Low Priority). This study would update RAPC's 1976 Joint Use Feasibility study conducted for Travis AFB and use the latest demand forecasts and Air Passenger Survey results to define the level of regional demand (passenger and air cargo) that might be served at Travis AFB and its potential to relieve the three primary Bay Area airports.
- **Moffett Federal Airfield Aviation Study** (Low Priority). The study would look at the need for Moffett Federal Airfield for emergency, limited air cargo, and future general aviation use. General aviation use could include serving corporate aircraft from SJC as the airport expands and needs more land for air passenger and air cargo facilities, or the consolidation of general aviation activity from other area airports, such as those potentially impacted

from rising sea levels. RAPC would consult with NASA, the affected cities, and SJC in developing a work scope for the study.

Issue 7: Projected increase in community noise exposure around all airports (2007-2035)

- **Long-Term Noise Forecasts for Each Airport** (Medium Priority). RAPC staff would continue to work with each airport to develop an approach to looking at long -term (2035) noise impacts in their future studies.
- **Focus Growth Review** (High Priority). The regional agencies would analyze the current Focus Growth population forecasts and examine alternative land use patterns that could reduce the future population exposed to airport noise around all three Bay Area airports.

Other Potential Work Tasks

- **Regional Airport Economic Benefits Study** (Medium Priority). This study would look at the connections between the quantity and efficiency of airline service provided at all three Bay Area airports and the regional economy, a connection that proved difficult to measure in this work effort. Working with Bay Area airports and the business community, RAPC staff could also develop a work plan for an airport economic benefits study that could be updated every 3-5 years.

Appendix A:
SUPPORTING EXHIBITS

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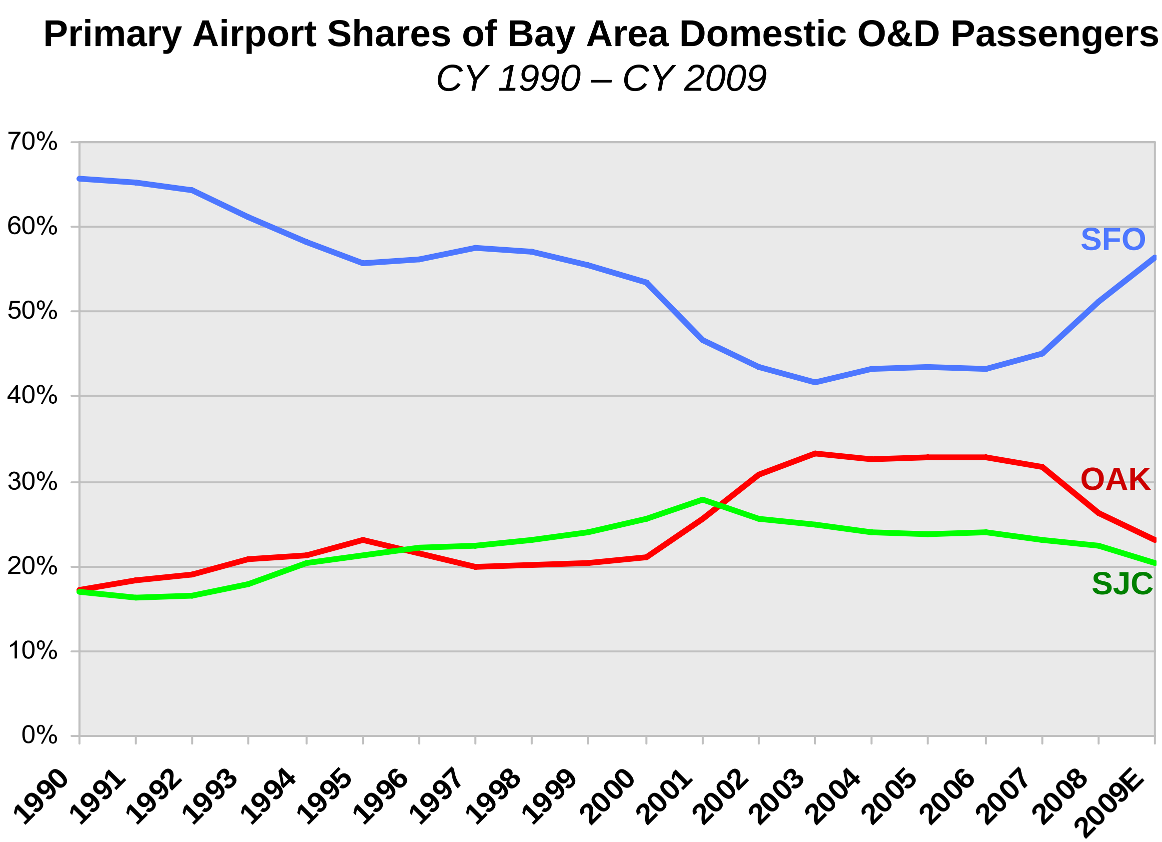
List of Supporting Exhibits

Exhibit 1

Historical Airport Shares of Regional Domestic O&D Passengers



Year	Share of Bay Area Dom O&D Psgrs OAK	SFO	SJC
1990	17.2%	65.6%	17.1%
1991	18.4%	65.2%	16.4%
1992	19.1%	64.3%	16.6%
1993	20.9%	61.2%	17.9%
1994	21.4%	58.3%	20.3%
1995	23.1%	55.7%	21.2%
1996	21.5%	56.1%	22.3%
1997	20.0%	57.5%	22.5%
1998	20.1%	57.0%	23.0%
1999	20.5%	55.5%	24.1%
2000	21.1%	53.4%	25.5%
2001	25.6%	46.6%	27.8%
2002	30.9%	43.4%	25.7%
2003	33.4%	41.6%	25.0%
2004	32.6%	43.3%	24.1%
2005	32.8%	43.4%	23.8%
2006	32.9%	43.2%	24.0%
2007	31.7%	45.1%	23.2%
2008	26.3%	51.2%	22.5%
2009E	23.1%	56.5%	20.4%

The 2007 Entry of Southwest Airlines, Virgin America and JetBlue Produced a Major Increase in SFO's Share of Bay Area Domestic Passengers

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Source: ACI-NA Airport Traffic Statistics; Airport Data

Exhibit 2

Historic and Forecast Bay Area Airport Passengers
1990 - 2008 and Forecast 2020, 2035

Enplaned/Deplaned Passengers

Year	Domestic Local	International Local	Connecting	Total	Percent of Total: Dom Local	Int'l Local	Conx
Actual							
1990	31,358,353	3,289,783	8,666,000	43,314,136	72.4%	7.6%	20.0%
1991	32,235,025	2,950,162	9,238,215	44,423,402	72.6%	6.6%	20.8%
1992	32,632,990	3,223,306	9,559,787	45,416,083	71.9%	7.1%	21.0%
1993	34,471,405	3,521,786	8,554,275	46,547,466	74.1%	7.6%	18.4%
1994	36,459,095	4,069,504	9,868,156	50,396,755	72.3%	8.1%	19.6%
1995	39,065,047	4,607,700	10,641,608	54,314,354	71.9%	8.5%	19.6%
1996	41,819,480	5,234,501	11,251,340	58,305,322	71.7%	9.0%	19.3%
1997	42,633,217	5,645,113	10,950,811	59,229,141	72.0%	9.5%	18.5%
1998	42,838,011	5,764,397	10,432,855	59,035,264	72.6%	9.8%	17.7%
1999	44,724,786	6,274,243	10,027,672	61,026,701	73.3%	10.3%	16.4%
2000	47,124,376	6,752,690	10,158,760	64,035,826	73.6%	10.5%	15.9%
2001	41,845,723	6,212,305	10,394,126	58,452,154	71.6%	10.6%	17.8%
2002	39,013,033	5,881,049	9,507,186	54,401,267	71.7%	10.8%	17.5%
2003	37,985,873	5,646,924	9,057,925	52,690,723	72.1%	10.7%	17.2%
2004	40,717,614	6,177,143	10,093,929	56,988,687	71.4%	10.8%	17.7%
2005	41,400,268	6,637,790	9,930,353	57,968,411	71.4%	11.5%	17.1%
2006	41,193,126	6,858,202	10,174,934	58,226,262	70.7%	11.8%	17.5%
2007	43,095,685	7,106,076	10,390,463	60,592,224	71.1%	11.7%	17.1%
2008 *	40,532,406	7,100,395	10,626,101	58,258,902	69.6%	12.2%	18.2%
Forecast: BASE CASE							
2020	50,813,298	10,545,741	13,948,076	75,307,115	67.5%	14.0%	18.5%
2035	63,484,270	17,695,216	20,137,483	101,316,970	62.7%	17.5%	19.9%
Forecast: LOW CASE							
2020	45,795,803	9,995,372	12,865,302	68,656,477	66.7%	14.6%	18.7%
2035	55,307,963	15,402,058	17,535,438	88,245,459	62.7%	17.5%	19.9%
Forecast: HIGH CASE							
2020	59,957,796	11,191,793	15,707,299	86,856,888	69.0%	12.9%	18.1%
2035	83,398,400	20,533,716	24,827,335	128,759,451	64.8%	15.9%	19.3%

Note: Includes OAK, SFO and SJC
* Domestic/international and connecting partially estimated for 2008.

Sources: Airport statistics and SH&E Analysis.

Exhibit 3

Forecast 2035 Passengers by Primary Bay Area Airport
for Base Case, Traffic Redistribution Scenario and Scenario B

Scenario	OAK	SFO	SJC	Total
<u>Foreast 2035 Passengers</u>				
Base Case	20,655,297	64,356,302	16,305,371	101,316,970
Traffic Redistribution	23,058,533	60,032,533	18,225,904	101,316,970
Scenario B	24,080,125	56,312,929	20,042,065	100,435,119
<u>Airport Passenger Shares</u>				
Base Case	20.4%	63.5%	16.1%	100.0%
Traffic Redistribution	22.8%	59.3%	18.0%	100.0%
Scenario B	24.0%	56.1%	20.0%	100.0%

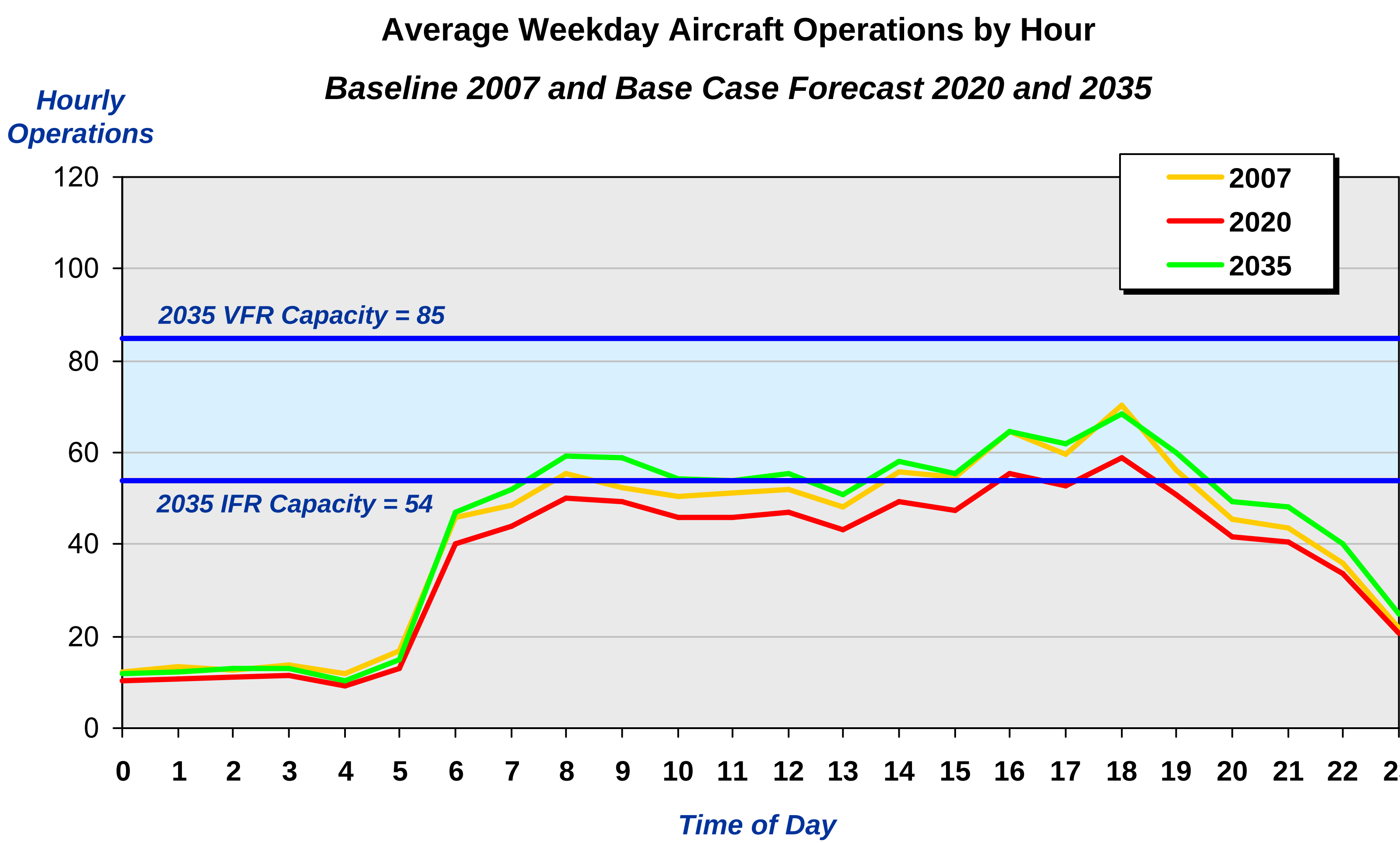
Exhibit 4

Forecast 2035 Aircraft Operations by Primary Bay Area Airport and Scenario

Scenario	OAK	SFO	SJC	Total
Base Case	354,945	526,595	242,739	1,124,279
Traffic Redistribution	377,392	489,258	260,783	1,127,433
Alternate Internal Airports	342,114	516,164	242,207	1,100,485
Alternate External Airports	350,632	522,713	235,290	1,108,636
High Speed Rail	336,449	499,949	220,350	1,056,748
New ATC Technologies	354,945	526,595	242,739	1,124,279
Demand Management	354,945	505,303	242,739	1,102,987
Scenario A (no HSR)	377,392	469,091	260,783	1,107,266
Scenario B (no HSR)	386,937	441,070	277,796	1,105,804
Scenario A with HSR	358,896	442,445	238,394	1,039,735
Scenario B with HSR	368,441	414,424	255,407	1,038,272
Scenario C (High Case)	446,366	535,976	336,404	1,318,746

Exhibit 5

OAK– Actual and Forecast Hourly Variation in Demand Compared to Capacities



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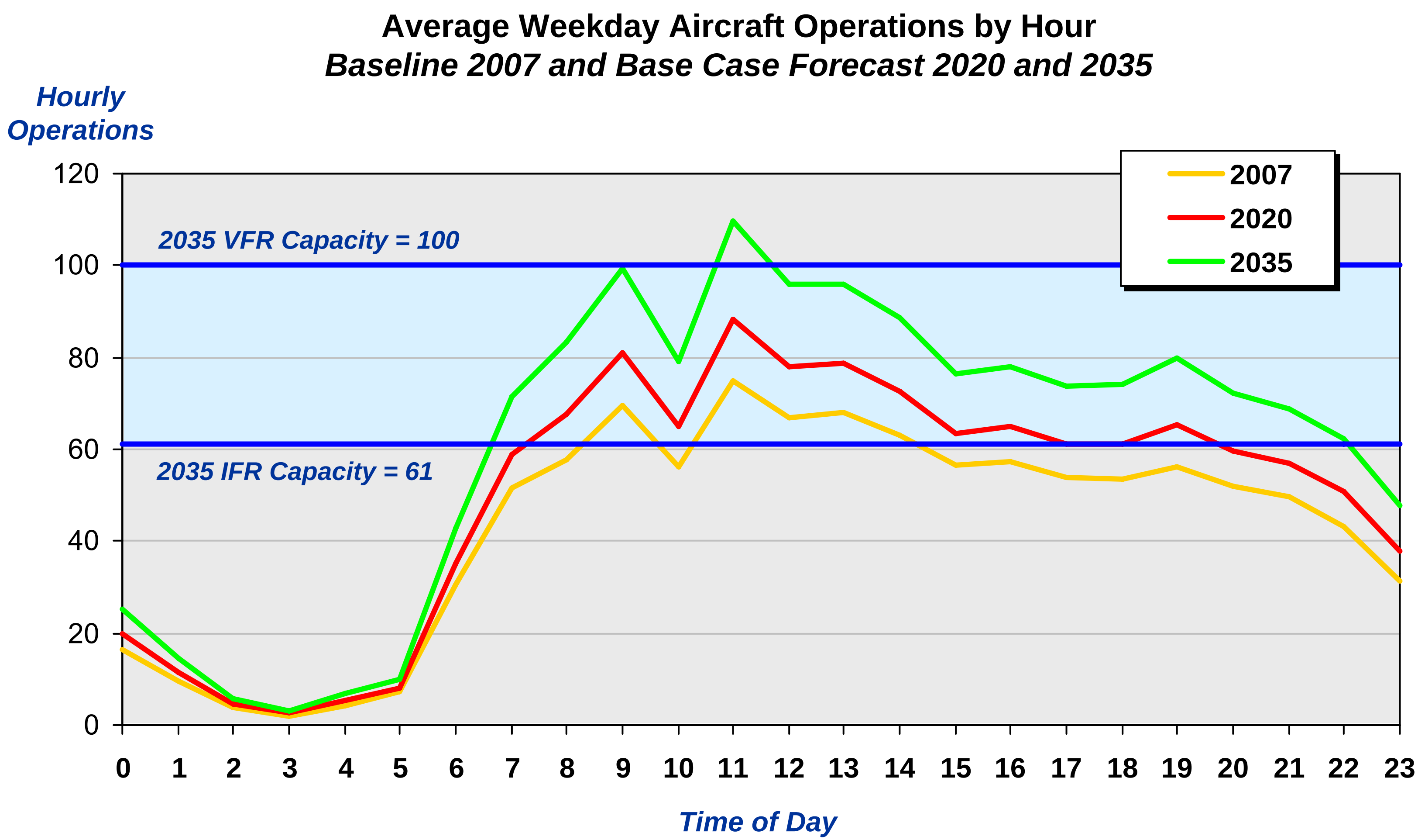
Notes: 2007 capacities = 105 VFR and 55 IFR; 2020 capacities = 88 VFR and 54 IFR

SFO – Actual and Forecast Hourly Variation in Demand Compared to Capacities



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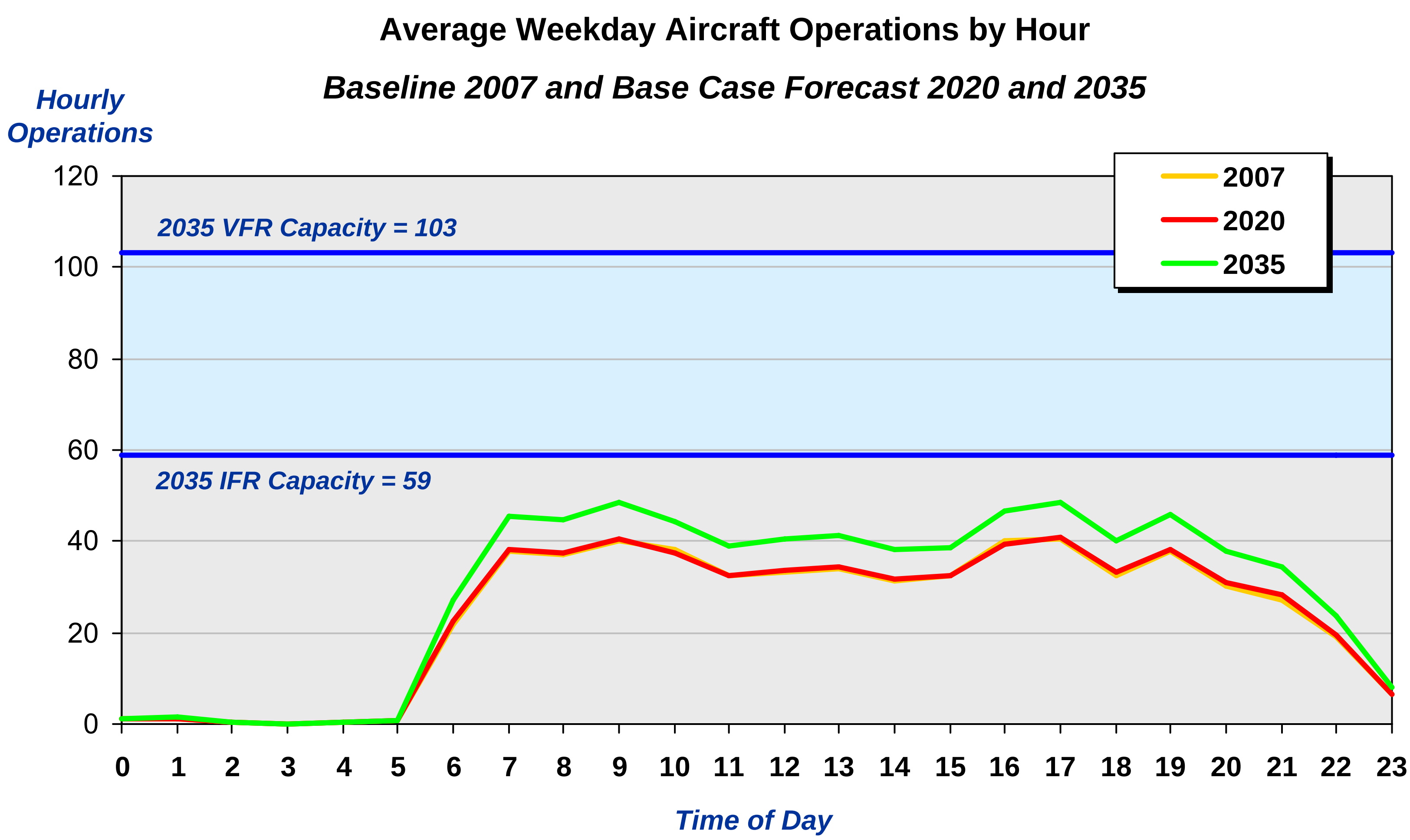
Notes: 2007 capacities = 95 VFR and 56 IFR; 2020 capacities = 99 VFR and 61 IFR

Exhibit 7

SJC– Actual and Forecast Hourly Variation in Demand Compared to Capacities



Notes: 2007 capacities = 92 VFR and 54 IFR; 2020 capacities = 98 VFR and 59 IFR

Exhibit 8

SFO - Average Aircraft Delays for Major Scenarios

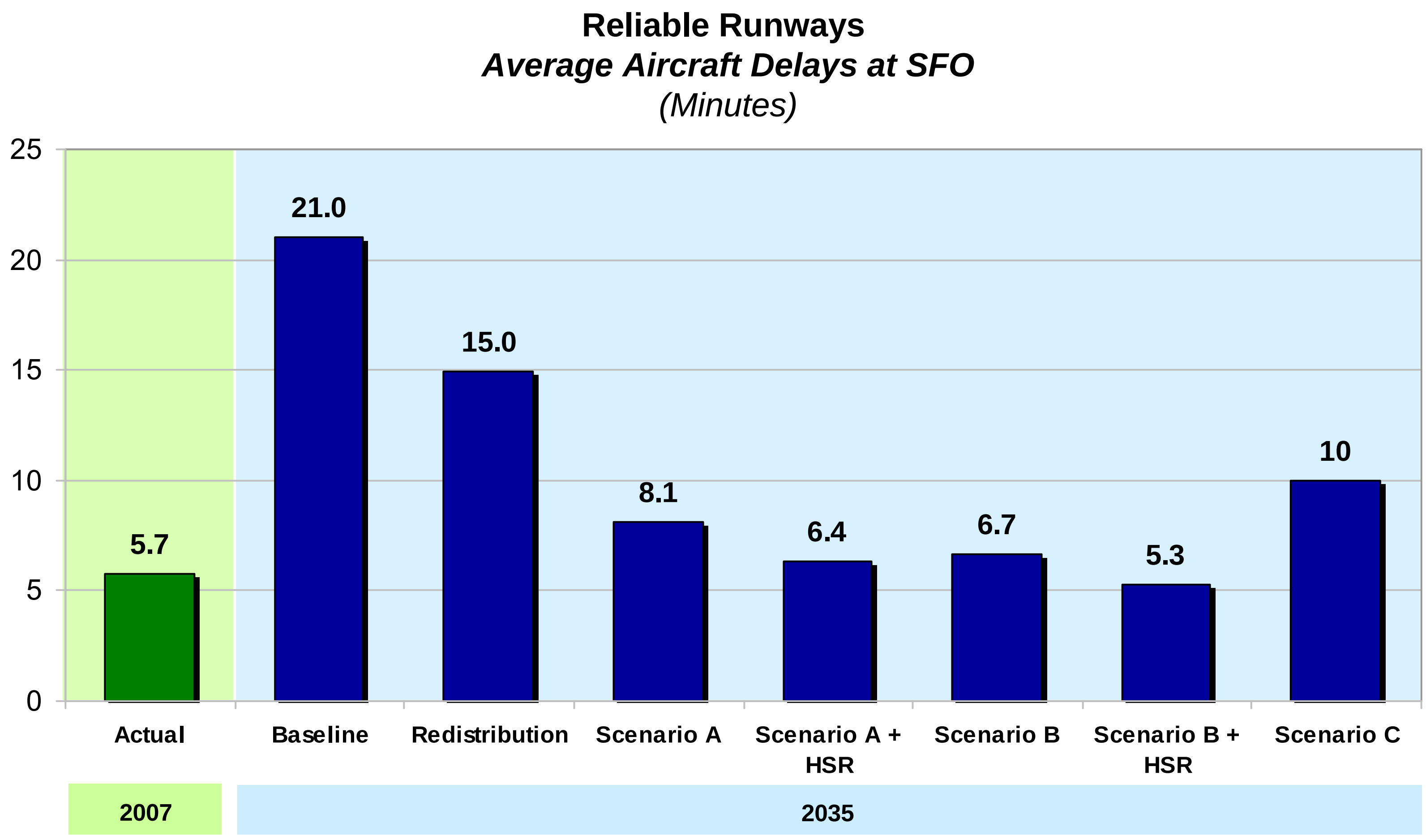


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Exhibit 9

OAK & SJC - Average Aircraft Delays for Major Scenarios

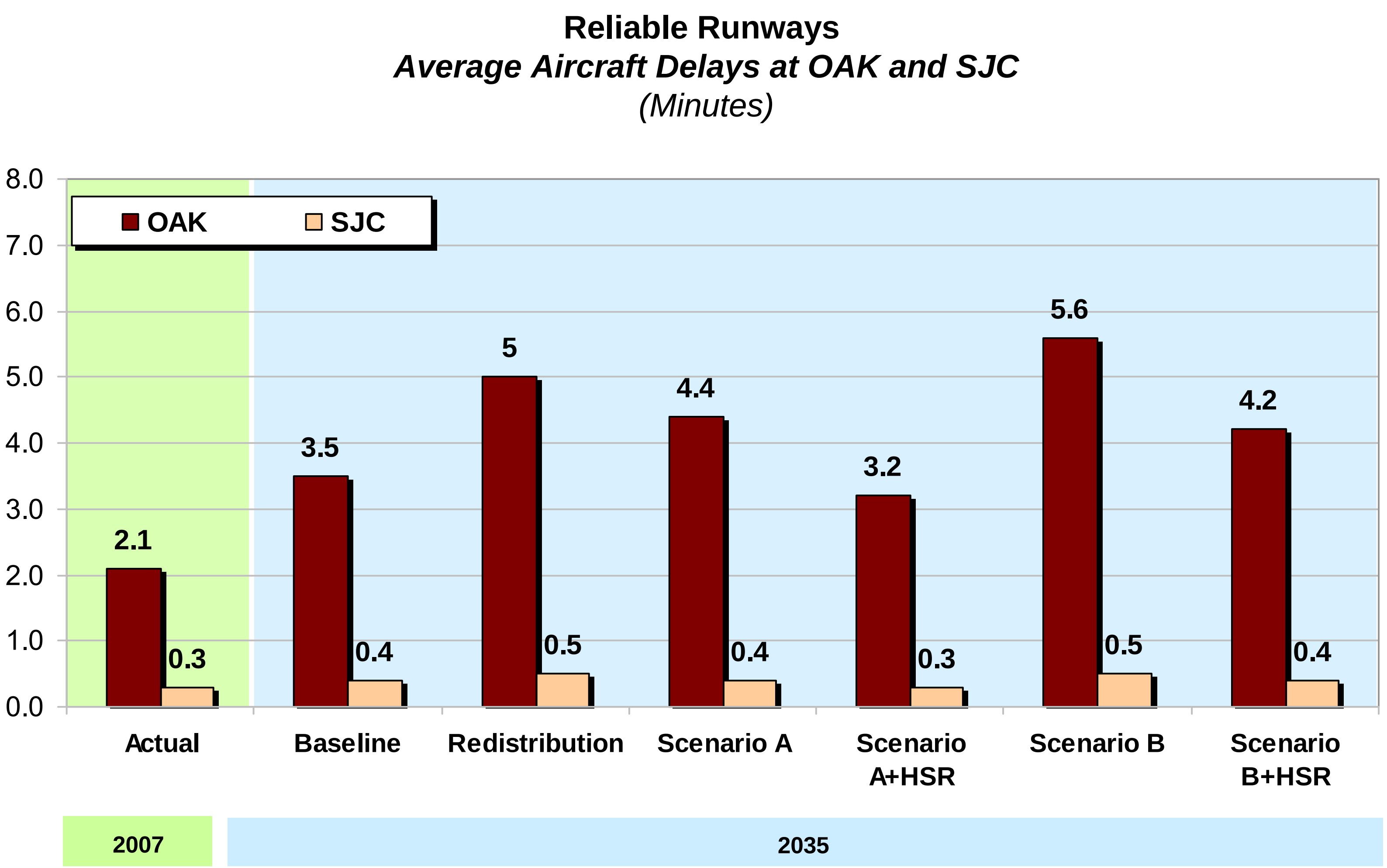

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Exhibit 10

Estimated Impact of Scenarios on Peak 3-Hour Aircraft Delays

Scenario	Avg. Peak 3-Hour Delay at SFO (minutes)	Pct Change vs. Base Case
2007	7.7	
Forecast 2035		
Base Case	27.5	
Scenario B (no HSR)	8.5	-68.9%
Scenario A (no HSR)	10.5	-61.9%
New ATC Technologies	12.0	-56.5%
Traffic Redistribution	19.4	-29.4%
High Speed Rail	21.7	-21.1%
Demand Management	22.2	-19.4%
Alternate Internal Airports	25.1	-8.8%
Alternate External Airports	26.7	-2.9%

Exhibit 11

Estimated Impact of Scenarios on Convenient Airports Goal (*Average Travel Time to Airports*)

Scenario	Avg. Travel Time to Airports (minutes)	Pct Change vs. Base Case
2007	48.7	
Forecast 2035		
Base Case	50.6	
Scenario B with HSR	47.9	-5.3%
Alternate Internal Airports	48.8	-3.6%
Scenario B (no HSR)	48.9	-3.5%
Scenario A with HSR	48.9	-3.3%
Alternate External Airports	49.7	-1.9%
High Speed Rail	49.7	-1.8%
Traffic Redistribution	49.9	-1.5%
Scenario A (no HSR)	49.9	-1.5%
New ATC Technologies	50.6	0.0%
Demand Management	50.6	0.0%

Exhibit 12

Estimated Impact of Scenarios on Convenient Airports Goal
(Average Cost of Airport Access per Passenger)

Scenario	Avg. Cost of Travel to Airports (dollars)	Pct Change vs. Base Case
2007	$19.22	
Forecast 2035		
Base Case	$20.68	
Alternate External Airports	$20.08	-2.9%
Alternate Internal Airports	$20.14	-2.6%
Scenario B with HSR	**$20.14**	-2.6%
Scenario B (no HSR)	**$20.19**	-2.4%
Scenario A with HSR	**$20.43**	-1.2%
Traffic Redistribution	$20.48	-1.0%
Scenario A (no HSR)	**$20.48**	-1.0%
High Speed Rail	$20.63	-0.2%
New ATC Technologies	$20.68	0.0%
Demand Management	$20.68	0.0%

Exhibit 13

Estimated Impact of Scenarios on Livable Communities Goal *(Population in 55 CNEL)*

Scenario	2007 Population in 55 CNEL	Pct Change vs. Base Case	*2035 Population in 55 CNEL*
2007	216,239		
Forecast 2035			
Base Case	263,574		*386,569*
High Speed Rail	251,403	-4.6%	*364,790*
Alternate External Airports	260,475	-1.2%	*380,843*
New ATC Technologies	261,496	-0.8%	*384,013*
Demand Management	262,365	-0.5%	*385,078*
Traffic Redistribution	266,230	1.0%	*392,685*
Scenario A with HSR	267,467	1.5%	*390,137*
Scenario B with HSR	272,797	3.5%	*399,914*
Alternate Internal Airports	275,491	4.5%	*400,530*
Scenario A (no HSR)	276,890	5.1%	*390,137*
Scenario B (no HSR)	282,895	7.3%	*414,620*

Exhibit 14

Noise Exposed Populations for Selected Scenarios

Airport	2007 Existing	2035 Scenario A 2007 Basis			2035 Scenario B 2007 Basis		
		2007 Basis	Focus Growth	Increase due to Fcst	2007 Basis	Focus Growth	Increase due to Fcst
65 CNEL							
OAK	486	684	728	44	717	764	47
SFO	20,196	37,221	44,893	7,672	37,395	45,101	7,706
SJC	1,749	3,880	7,385	3,505	4,715	9,082	4,367
CCR	20	28	33	5	28	33	5
STS	143	214	224	10	225	236	11
SUU	786	786	1,008	222	786	1,008	222
Total Primary Airports	22,431	41,785	53,006	11,221	42,827	54,947	12,120
	90.0%	89.1%	84.7%		87.3%	82.1%	
Total Primary + Secondary	23,380	42,813	54,271	11,458	43,866	56,224	12,358
55 CNEL							
OAK	35,003	45,445	52,414	6,969	47,157	54,443	7,286
SFO	127,289	153,266	184,790	31,524	153,583	185,172	31,589
SJC	53,947	65,003	152,530	87,527	68,940	159,285	90,345
CCR	2,811	3,393	3,906	513	3,393	3,906	513
STS	694	931	1,049	118	970	1,100	130
SUU	8,852	8,852	10,714	1,862	8,852	10,714	1,862
Total Primary Airports	216,239	263,714	389,734	126,020	269,680	398,900	129,220
Total Primary + Secondary	228,596	276,890	405,403	128,513	282,895	414,620	131,725

Exhibit 15

Oakland (OAK): Airfield Layout and Key Operating Factors

- **OAK is two airports in one.**
  - The North Field is primarily used by General Aviation and Air Taxi operators
  - The South Field is used by nearly all commercial carriers
- **OAK has a noise policy that discourages North Field jet departures to the west and jet arrivals from the west.**
- **The GA activity using the North Field has been a large part of OAK's activity.**
  - The forecast predicts a significant reduction in this activity from 2007 to 2020.

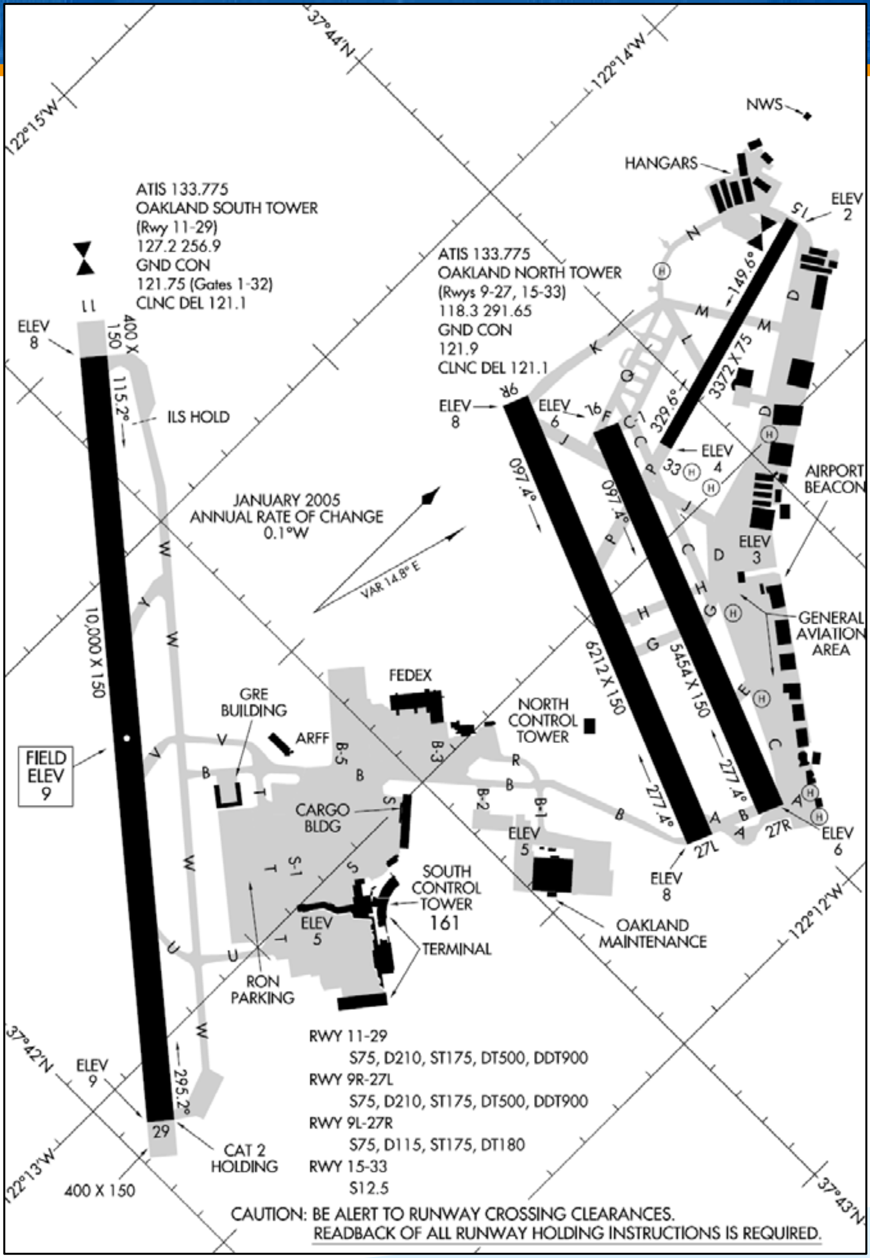

Exhibit 16

San Francisco (SFO): Airfield Layout and Key Operating Factors

- **The preferred configuration is wingtip-to-wingtip arrivals to 28L & 28R with dual departures on 01L & 01R.**
- **SOIA approaches provide dual arrival runway capacity on 28L & 28R down to weather minimums of 2100 ft ceiling and 4 nm visibility.**
  - Used < 2% of the time
- **Capacity is substantially diminished during IFR and East flow conditions.**

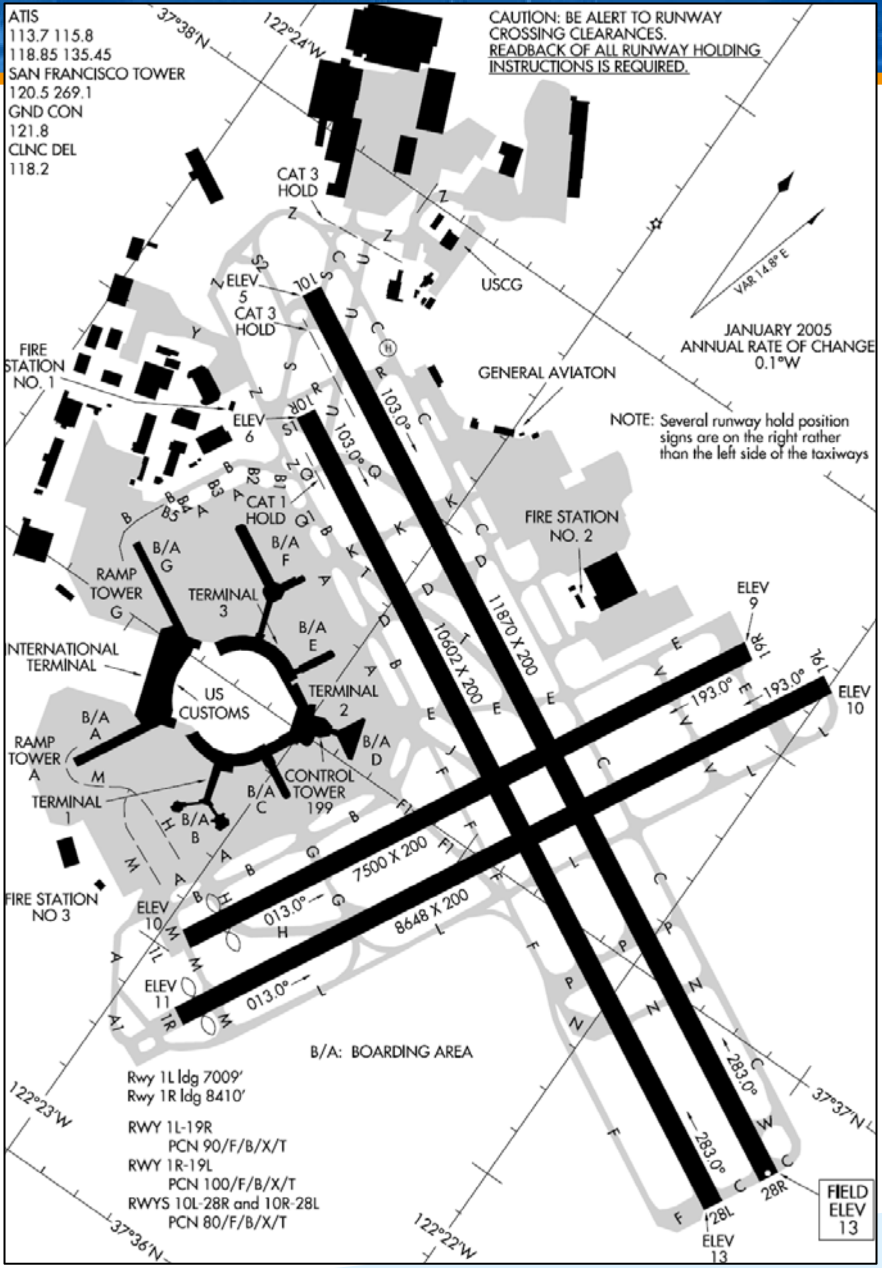

Exhibit 17

San Jose (SJC): Airfield Layout and Key Operating Factors

- **Commercial jets arrive on 12R-30L and depart on 12L-30R**
- **All jet departures use runway 12L-30R**
- **Runway 11-29, on the south side of the airport, is used almost exclusively by GA operators**

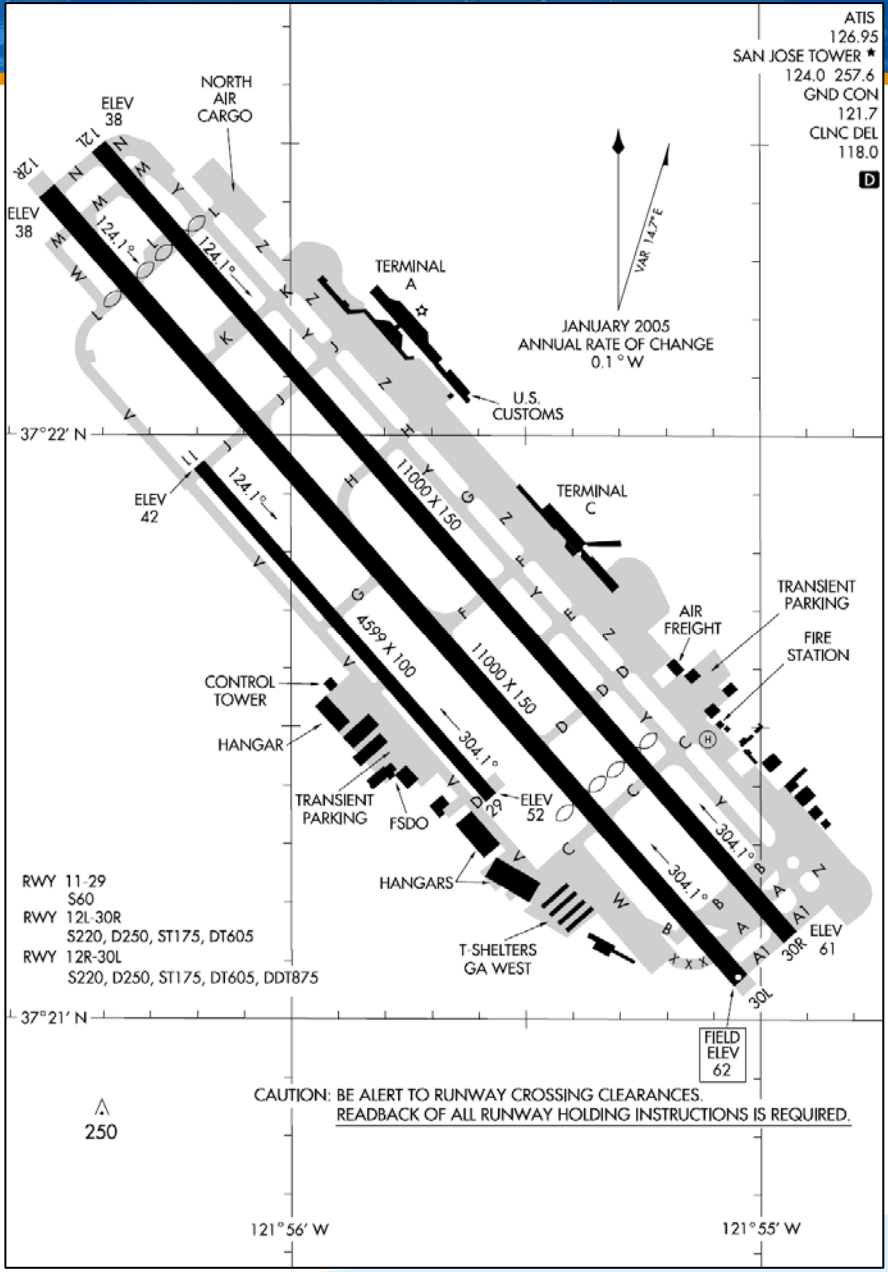

EXHIBIT 18
RASPA STUDY REPORTS

MAJOR REPORTS

- Baseline Aviation Activity Forecasts for Primary Bay Area Airports (August 27, 2009)
- Mid-Point Screening Report (July 26, 2010)
- Baseline Runway Capacity and Delays Report (August 2010)
- Final Scenario Analysis (January 5, 2011)

TECHNICAL REPORTS

- Forecast Demand Allocation Methodology (June 2010)
- High Speed Rail Scenario Passenger Diversion (June 29, 2010)
- Noise Technical Report (July 2010)
- Ground Access Analysis Methodology and Results (July 2010)
- Bay Area Airport Emissions Inventory for Base Year (2007) and Target Analysis Scenarios in 2035 (August 2010)
- Bay Area Forecast Tracking System Recommendations (June 2011)
- Bay Area Airport Congestion Tracking System Recommendations (June 2011)
- Conceptual Cost Estimates for Accommodating Air Service at Alternative Airports (May 2011)

PUBLIC MEETING REPORTS

- Mid-Point Meeting Summary Report (May 2010)
- Round 2 Meeting Summary Report (April 2011)

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